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**Cho et al.**

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(54) **METHOD FOR MANUFACTURING LIGHT  
EMITTING DEVICE PACKAGE**

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(30) **Foreign Application Priority Data**

Jan. 25, 2013 (KR) ..... 10-2013-0008633

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**H01L 21/00** (2006.01)  
**H01L 33/00** (2010.01)

(52) **U.S. Cl.**  
CPC ..... **H01L 33/0079** (2013.01); **H01L 33/0095**  
(2013.01); **H01L 2933/0033** (2013.01)

(58) **Field of Classification Search**  
None  
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,488,621	B2	2/2009	Epler et al.	
7,977,686	B2	7/2011	Ibbetson et al.	
8,227,271	B1	7/2012	Ho	
2006/0091409	A1*	5/2006	Epler .....	H01L 33/0079 257/95
2013/0130440	A1*	5/2013	Hu .....	H01L 24/83 438/107

FOREIGN PATENT DOCUMENTS

JP	2010157679	A	7/2010
KR	1020060020605	A	3/2006
KR	1020110047781	A	5/2011
KR	1020110076610	A	7/2011
KR	101128261	B1	3/2012

\* cited by examiner

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(57) **ABSTRACT**

A method for manufacturing a light emitting device package is provided. In the method, a growth substrate including a plurality of light emitting devices disposed on a top surface of the growth substrate is prepared. A first package substrate having a bonding pattern corresponding to a portion of the plurality of light emitting devices is prepared, and the bonding pattern is disposed on a top surface of the first package substrate. The portion of the plurality of light emitting devices and the bonding pattern are bonded by disposing the top surface of the growth substrate to face the top surface of the first package substrate. The portion of the plurality of light emitting devices is separated from the growth substrate. The portion of the plurality of light emitting devices joined to the bonding pattern is packaged.

**8 Claims, 18 Drawing Sheets**

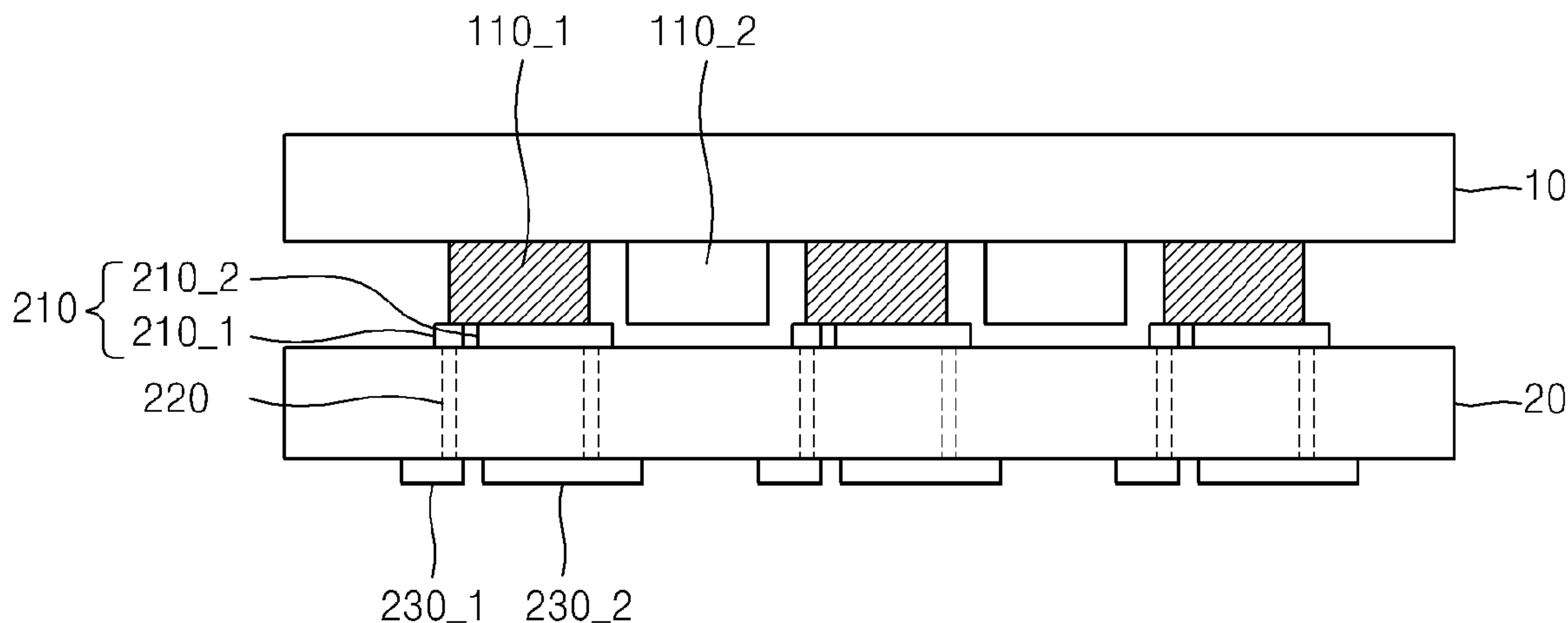


FIG. 1A

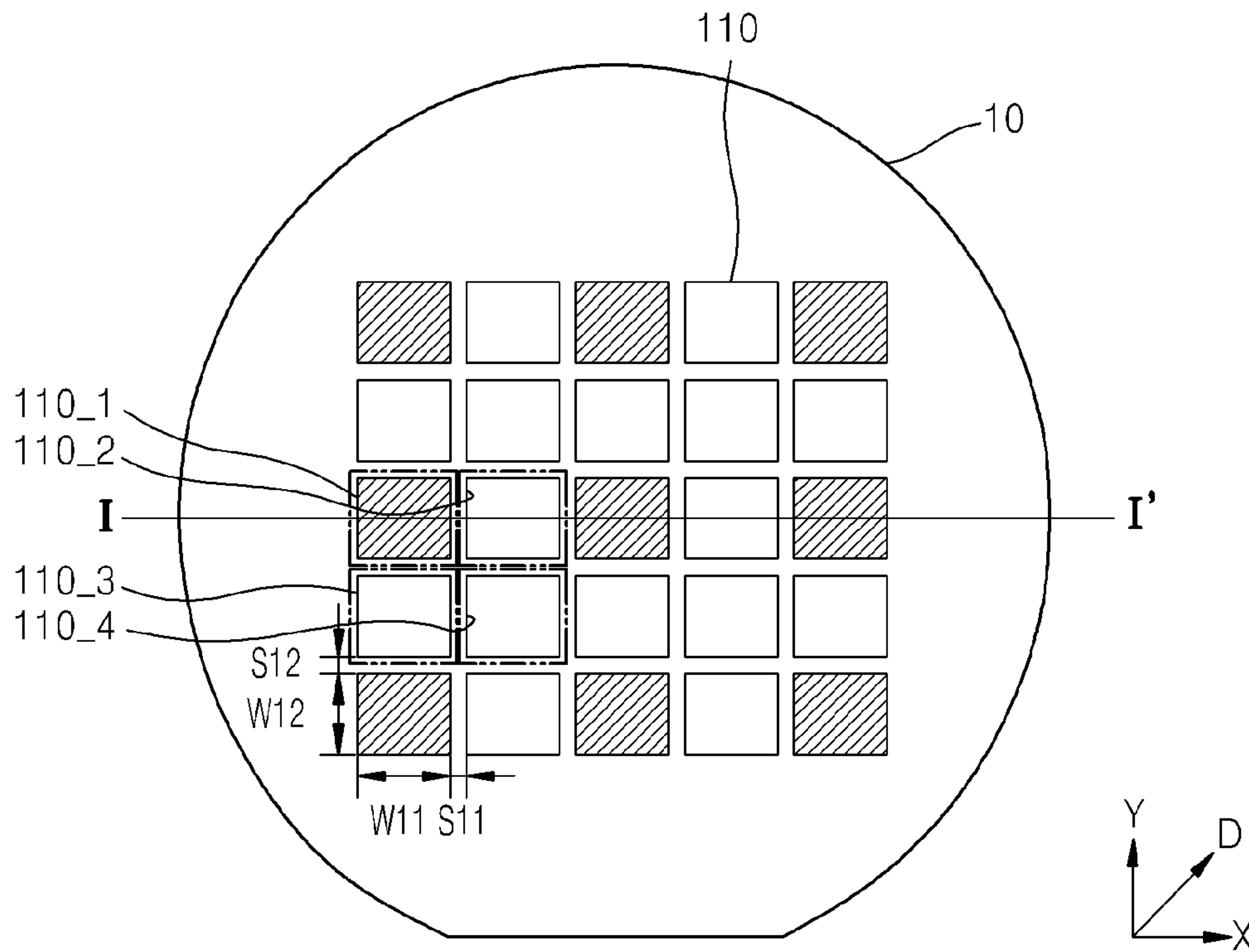


FIG. 1B

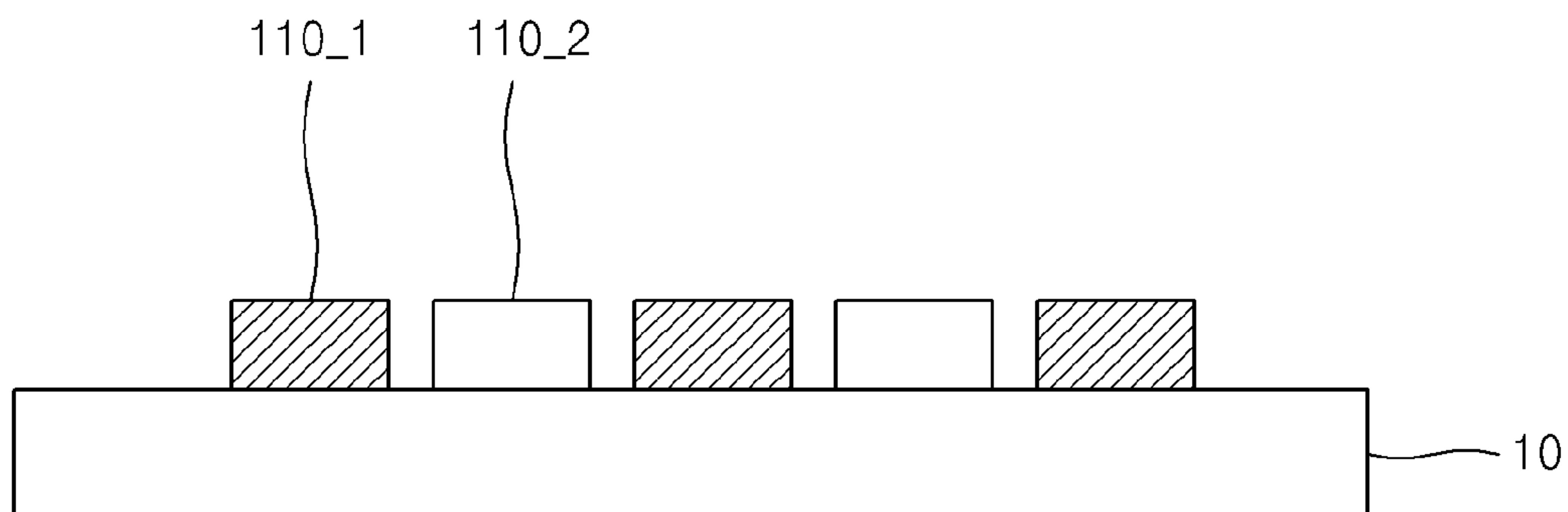


FIG. 2A

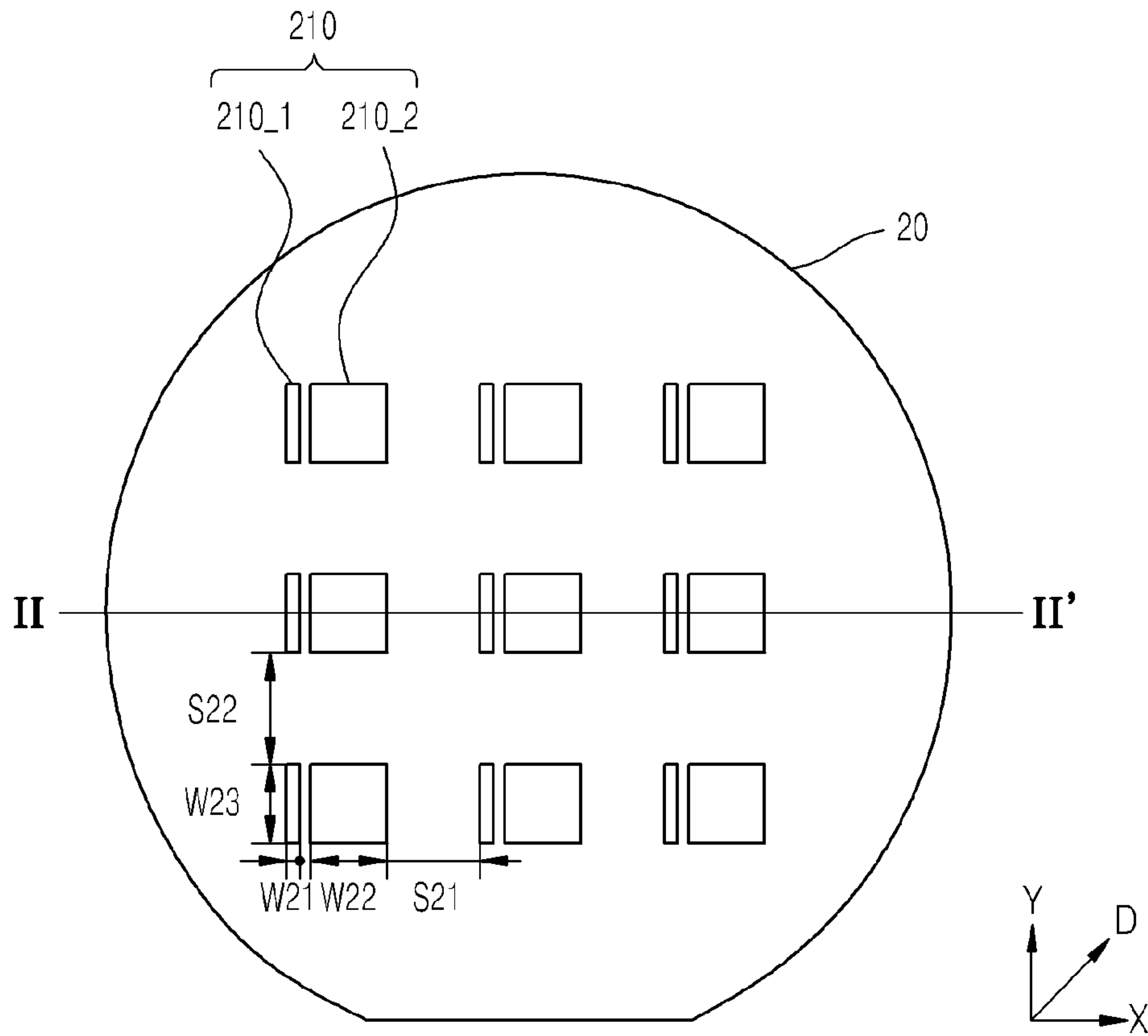


FIG. 2B

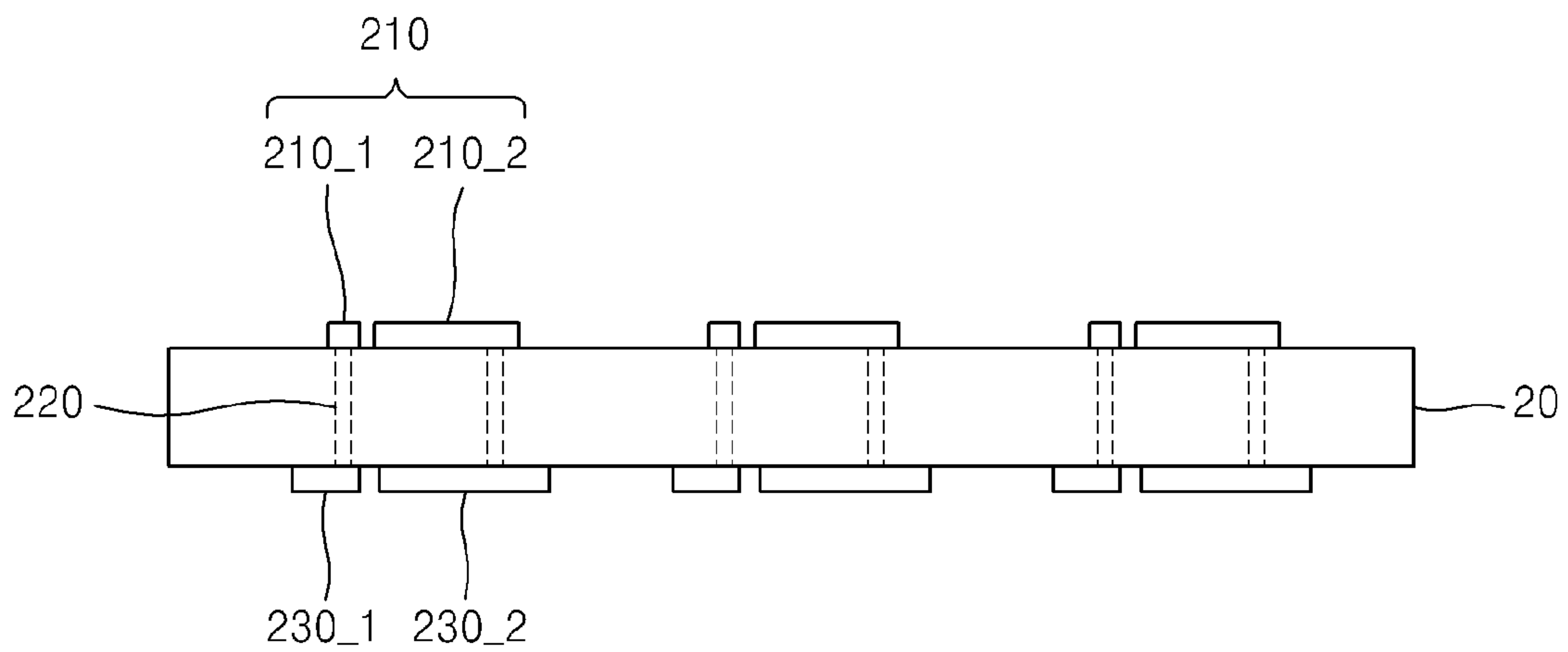


FIG. 3

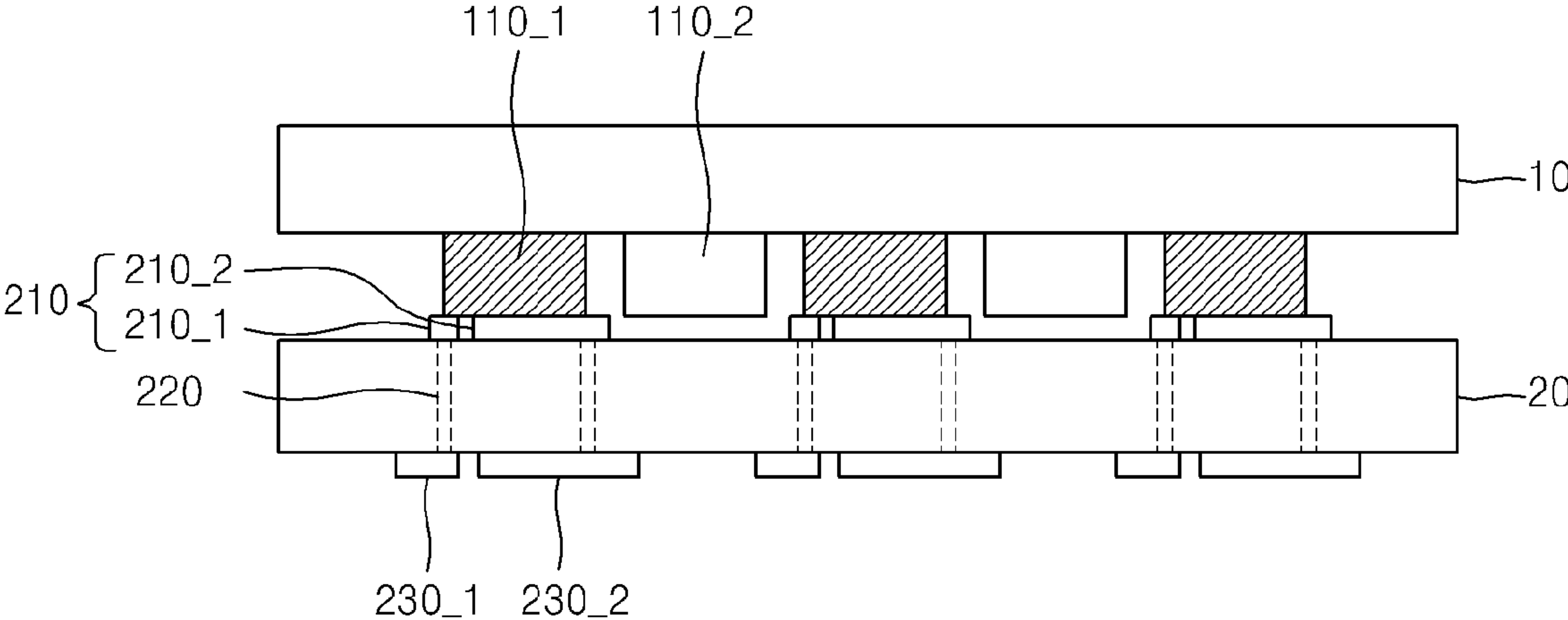


FIG. 4

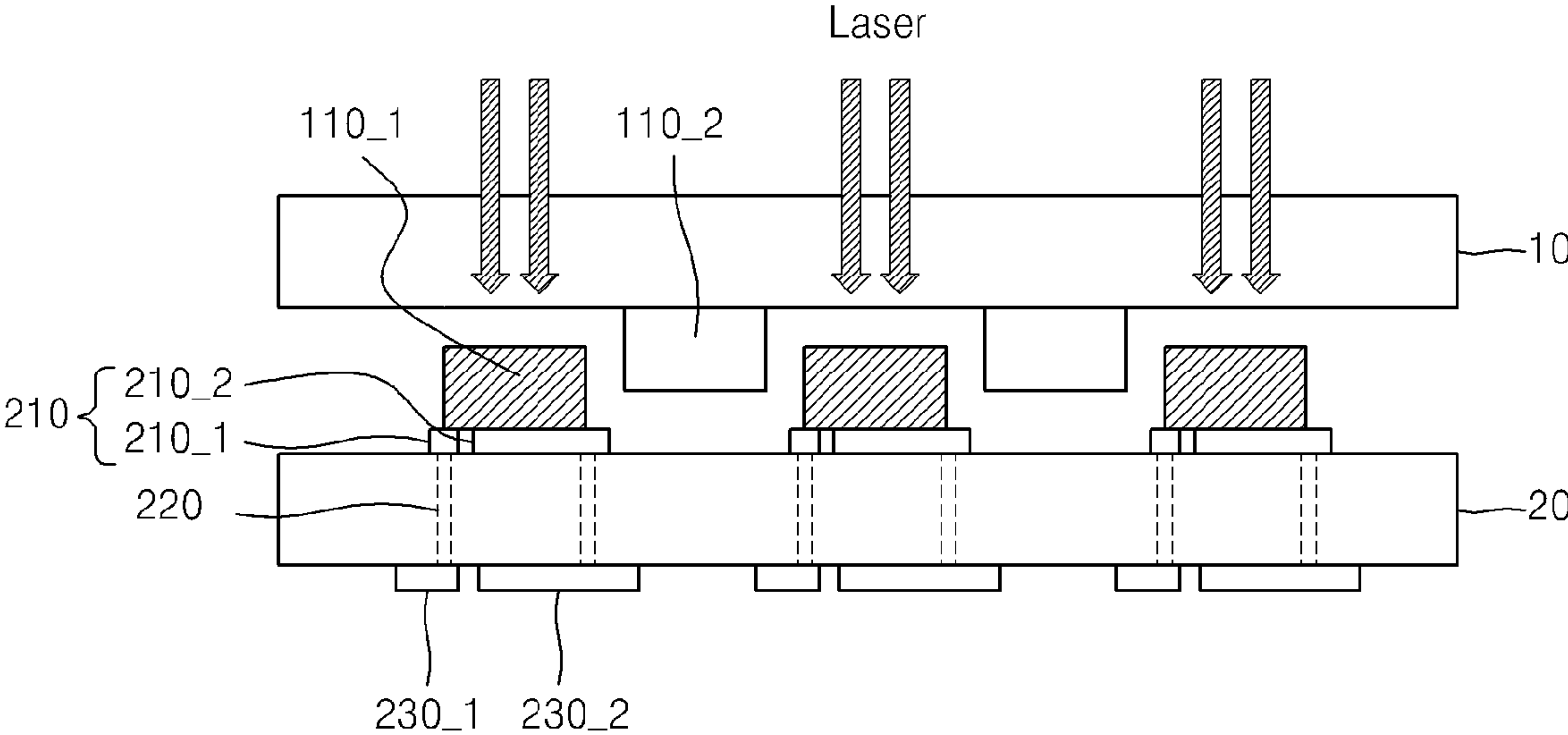


FIG. 5

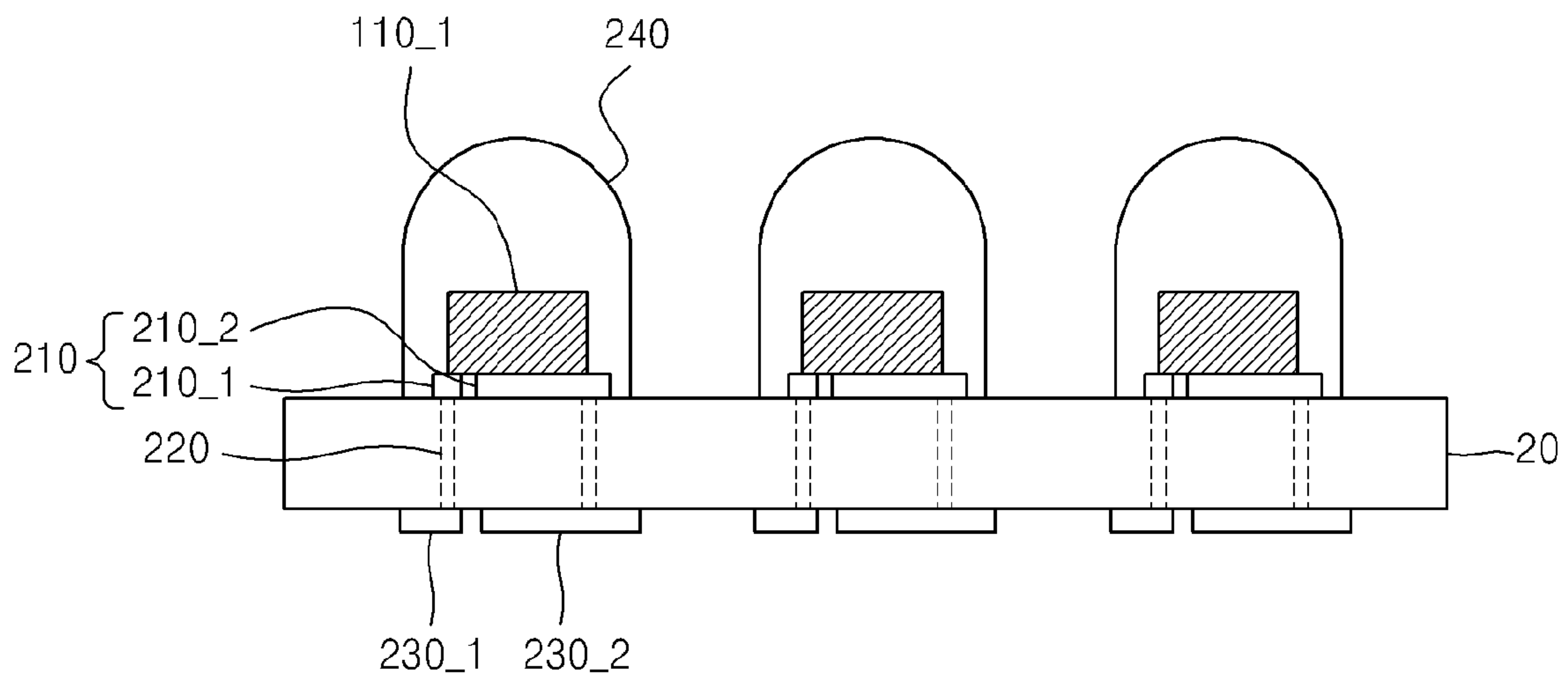


FIG. 6

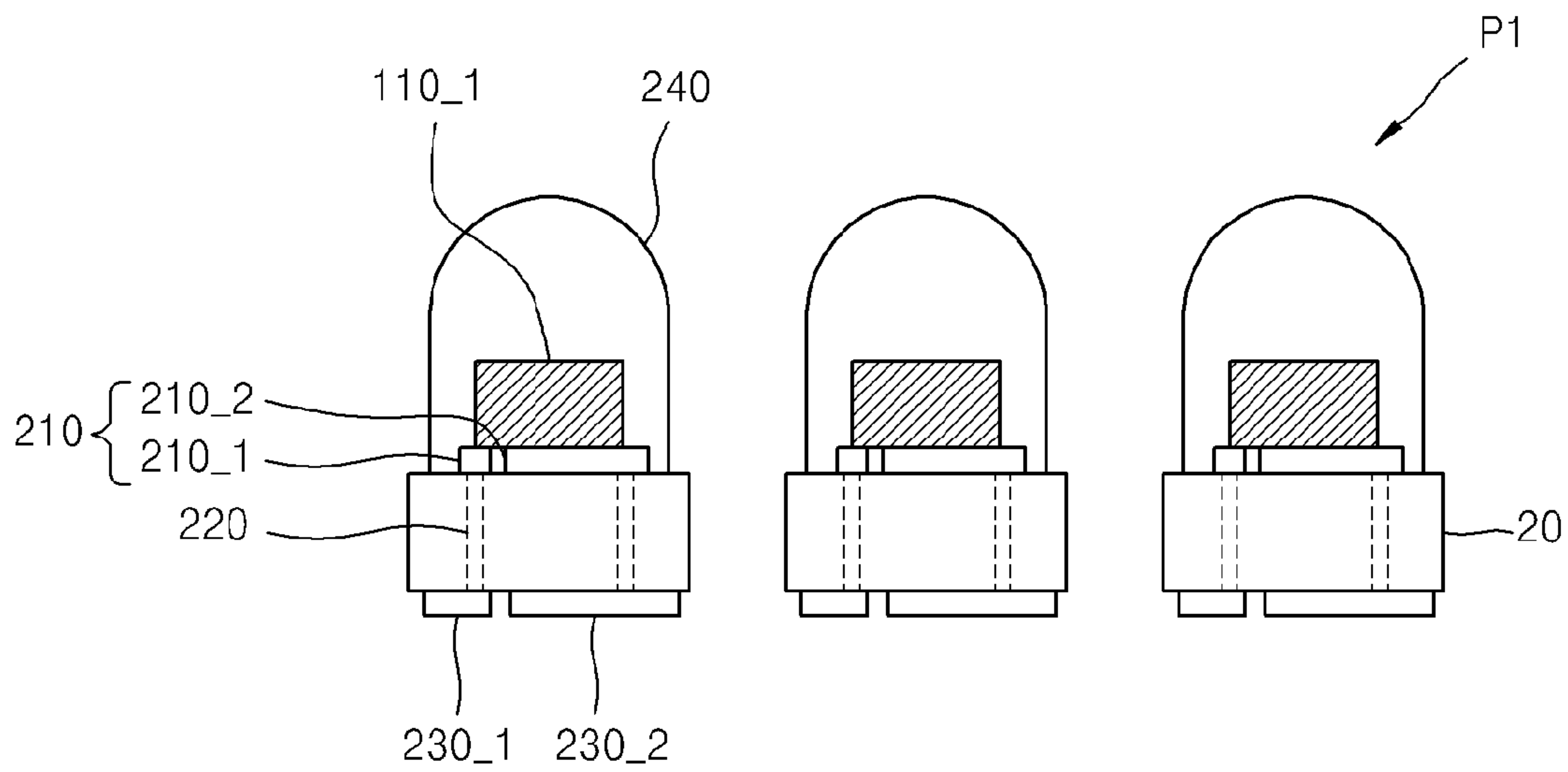


FIG. 7A

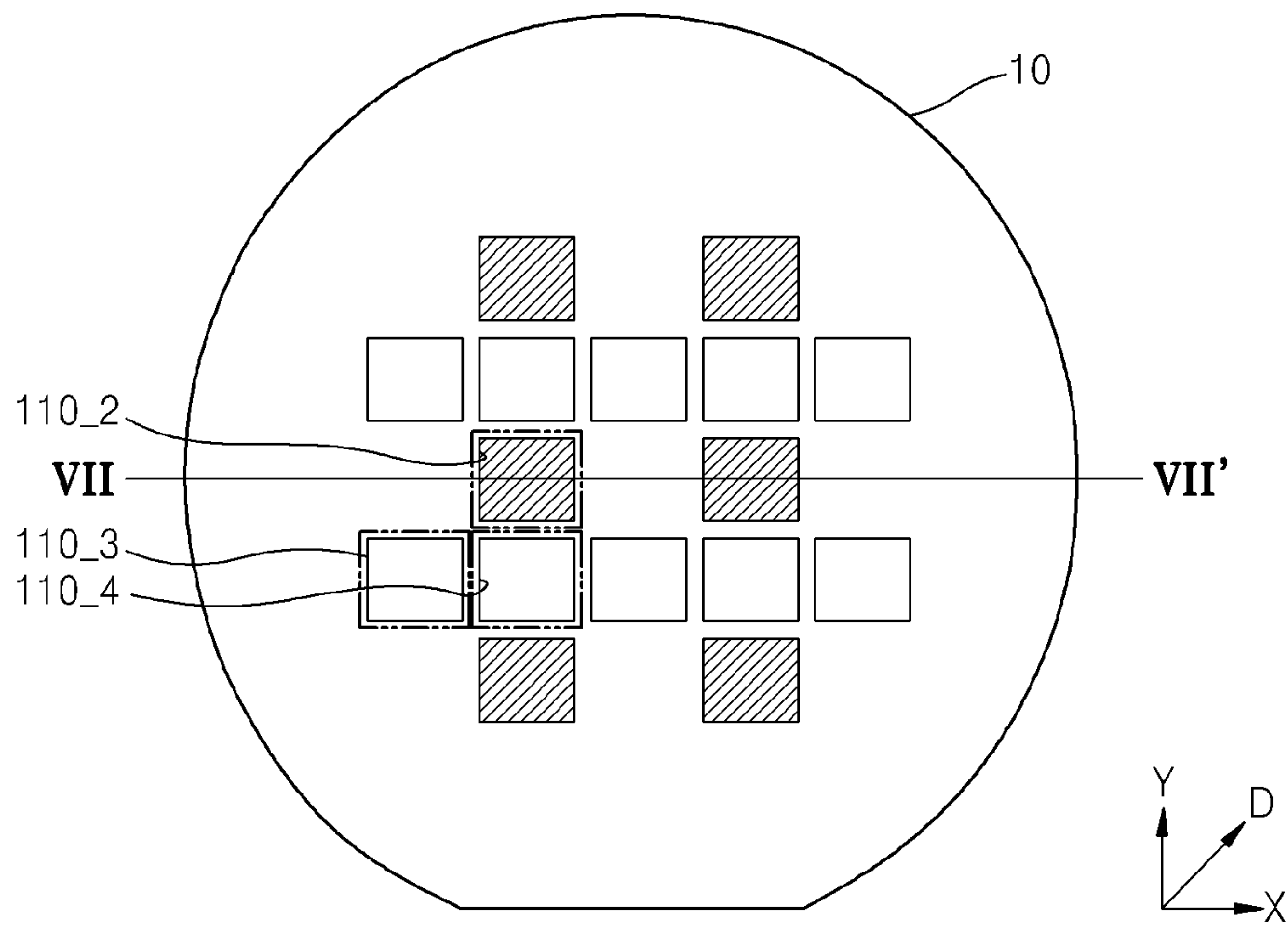


FIG. 7B

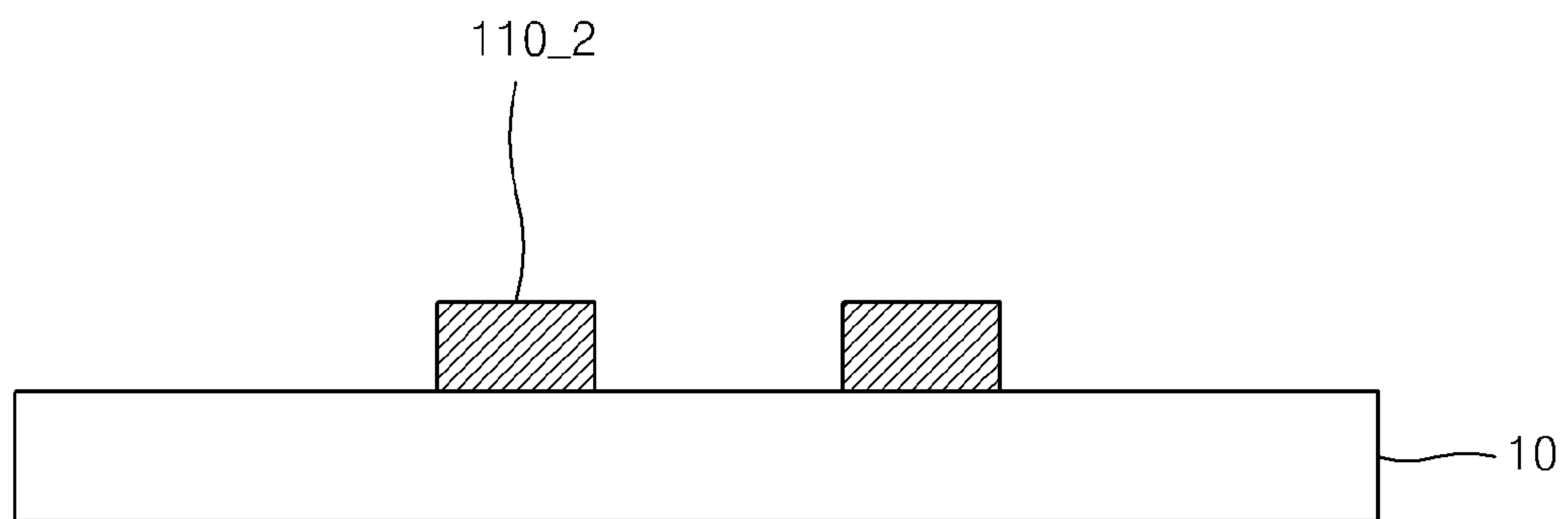


FIG. 8A

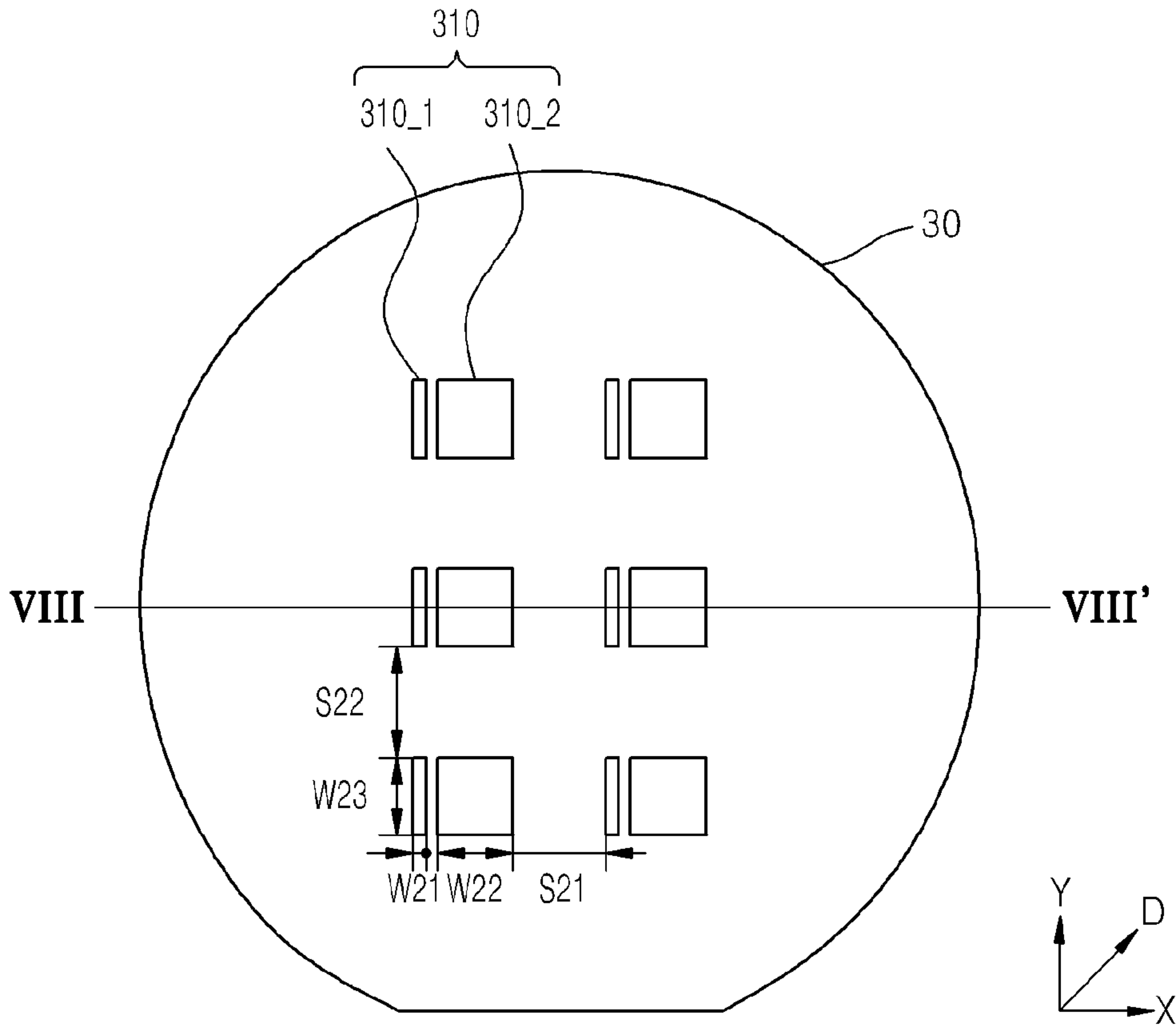


FIG. 8B

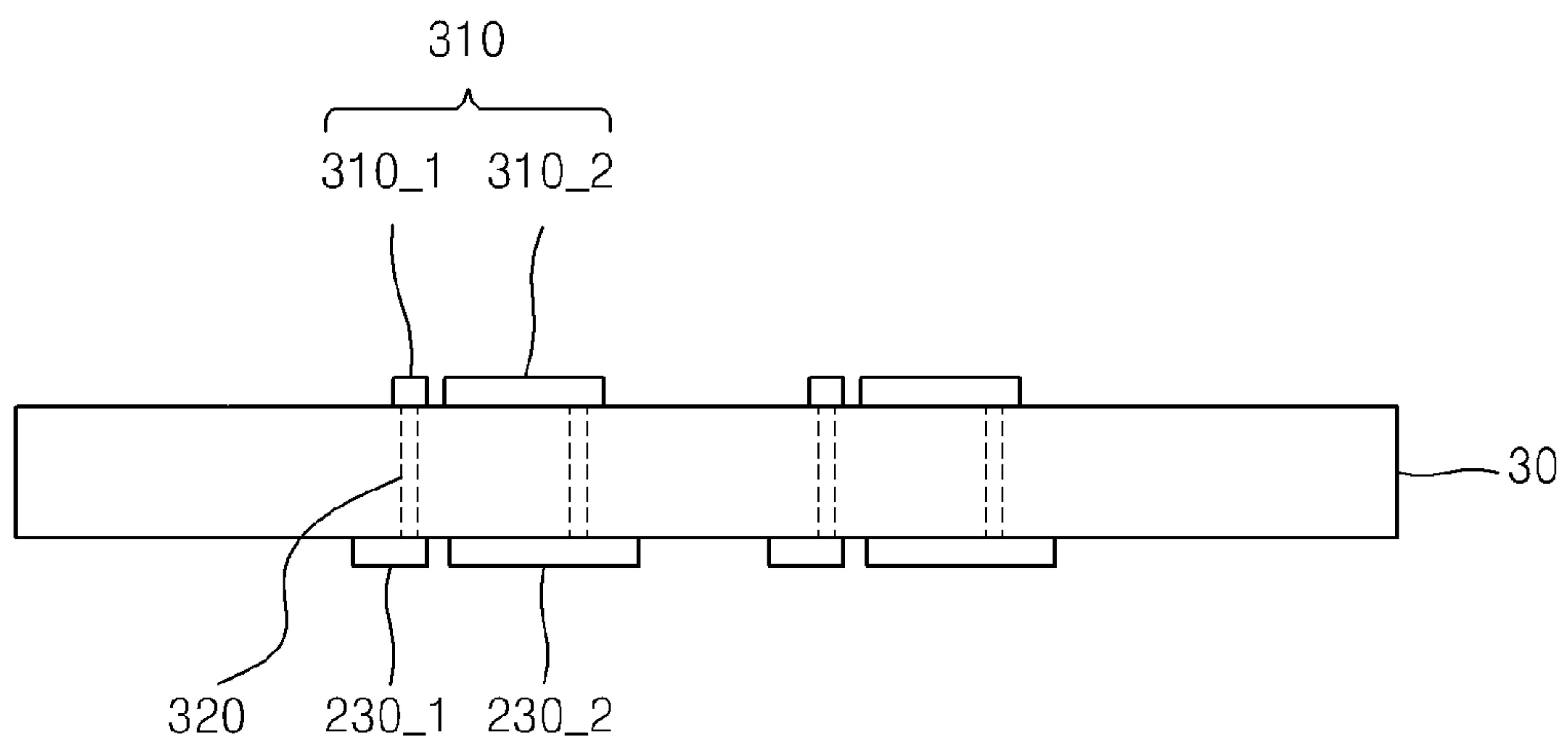




FIG. 9

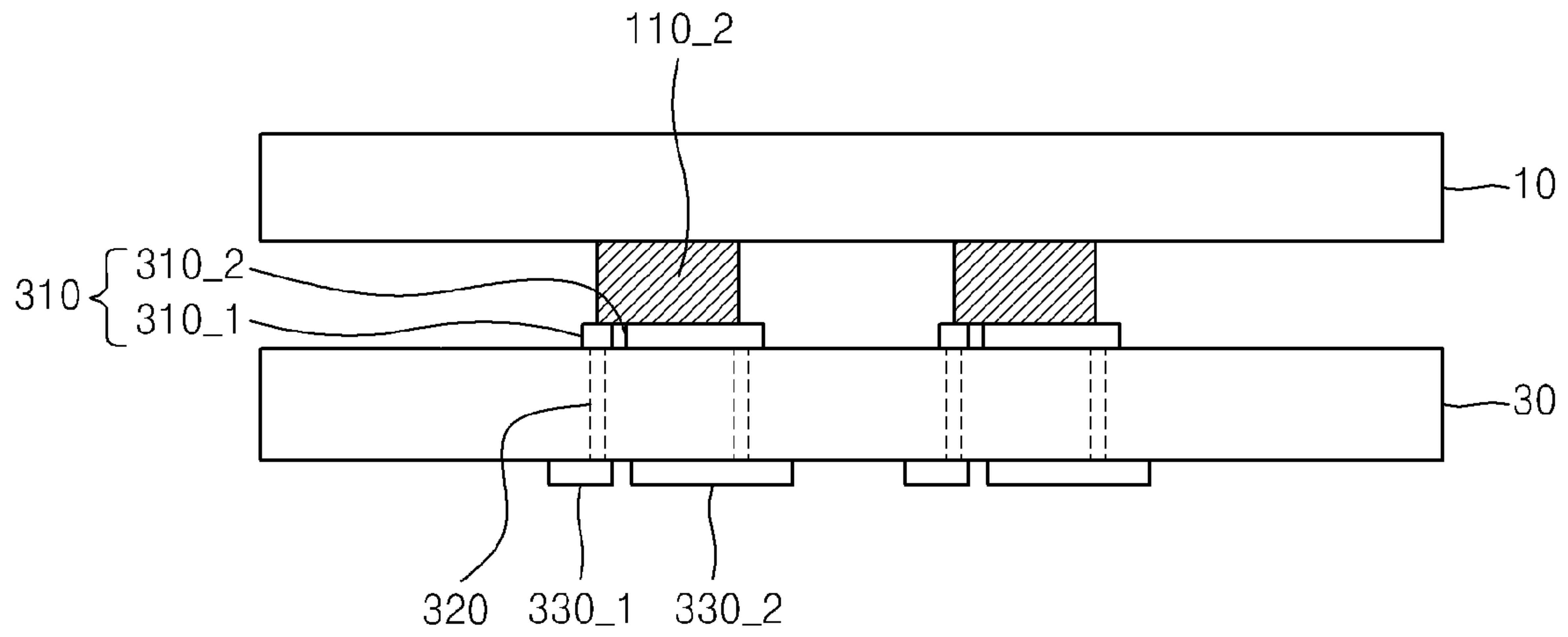


FIG. 10

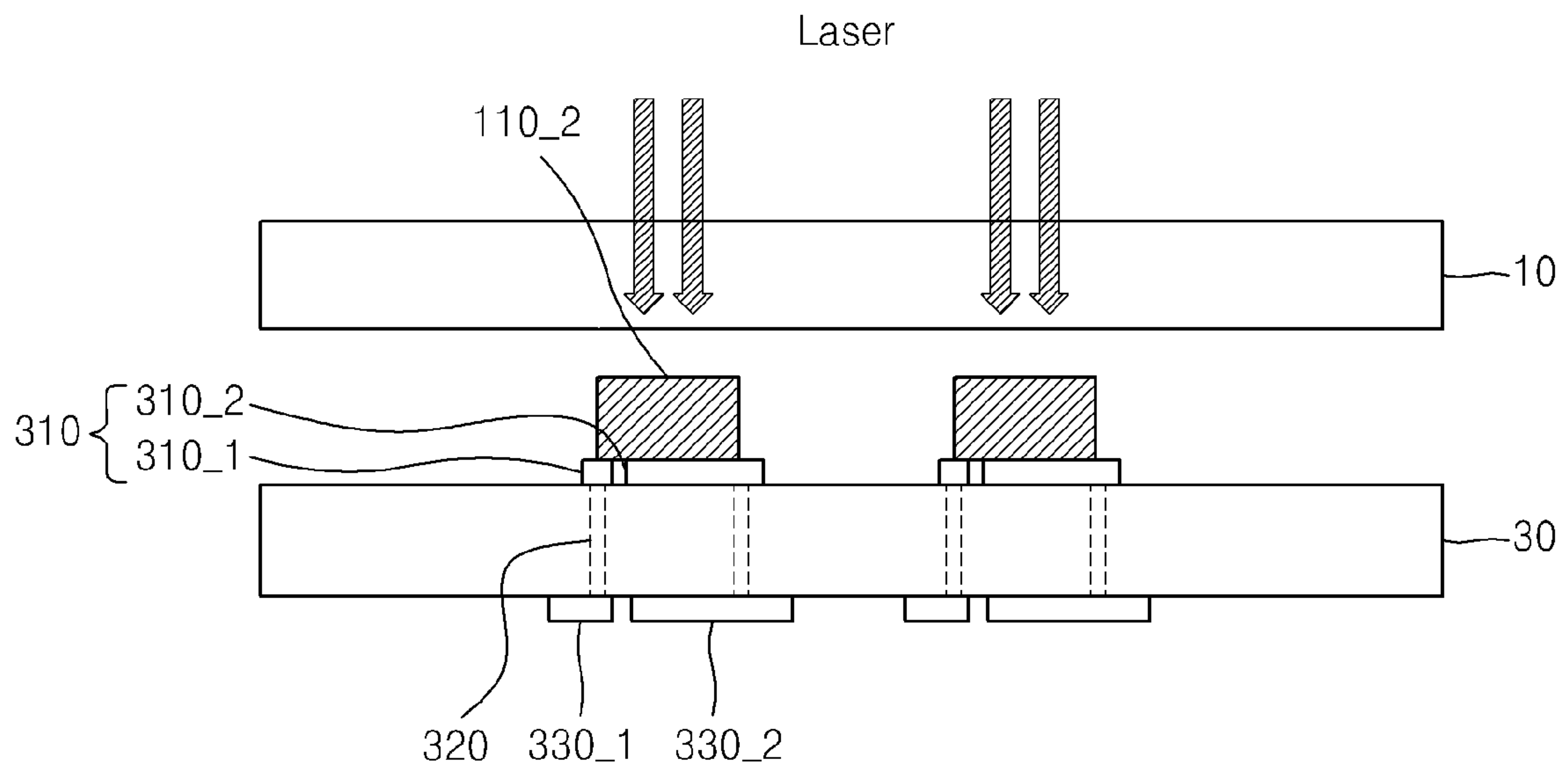




FIG. 11

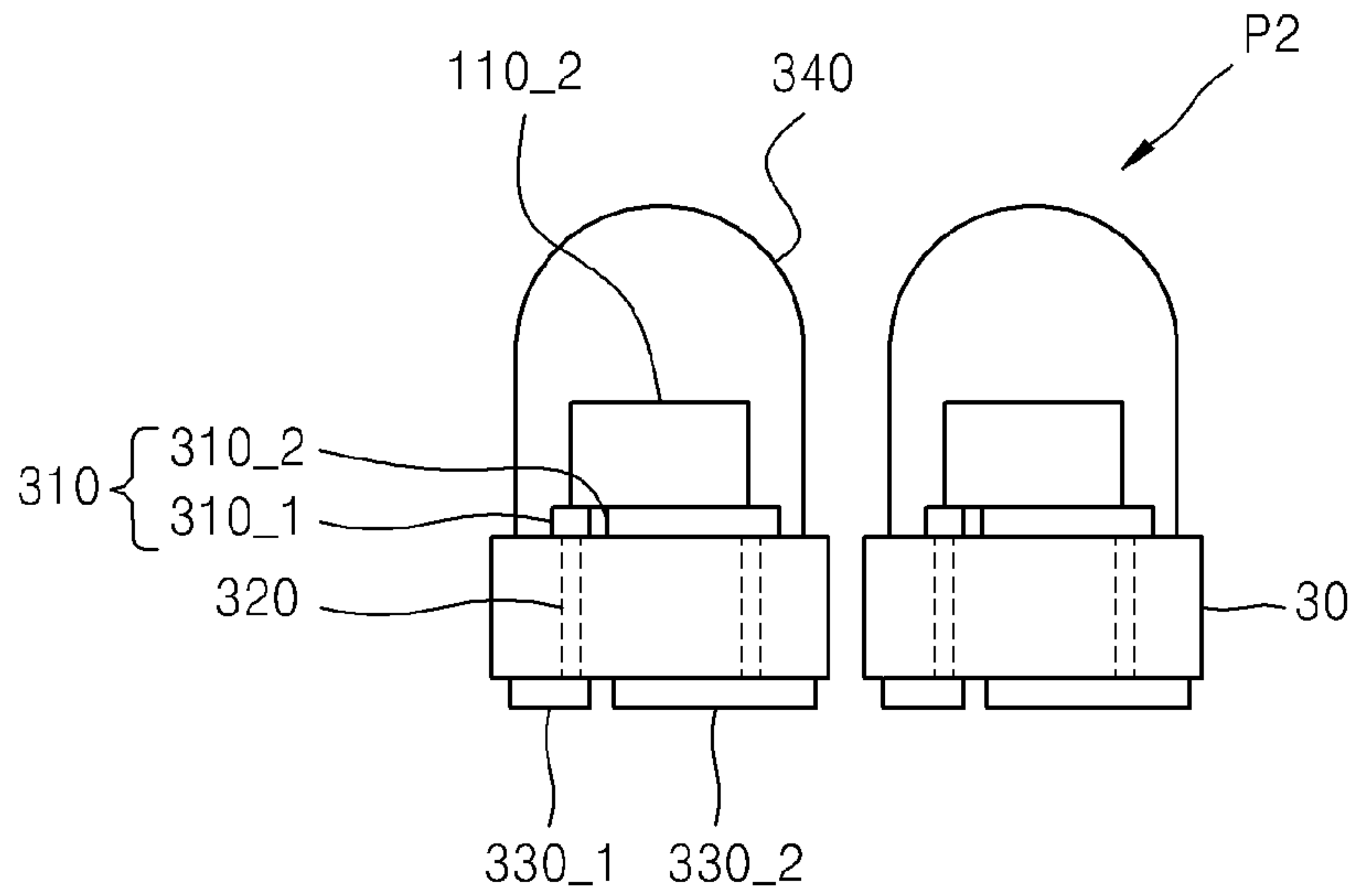


FIG. 12

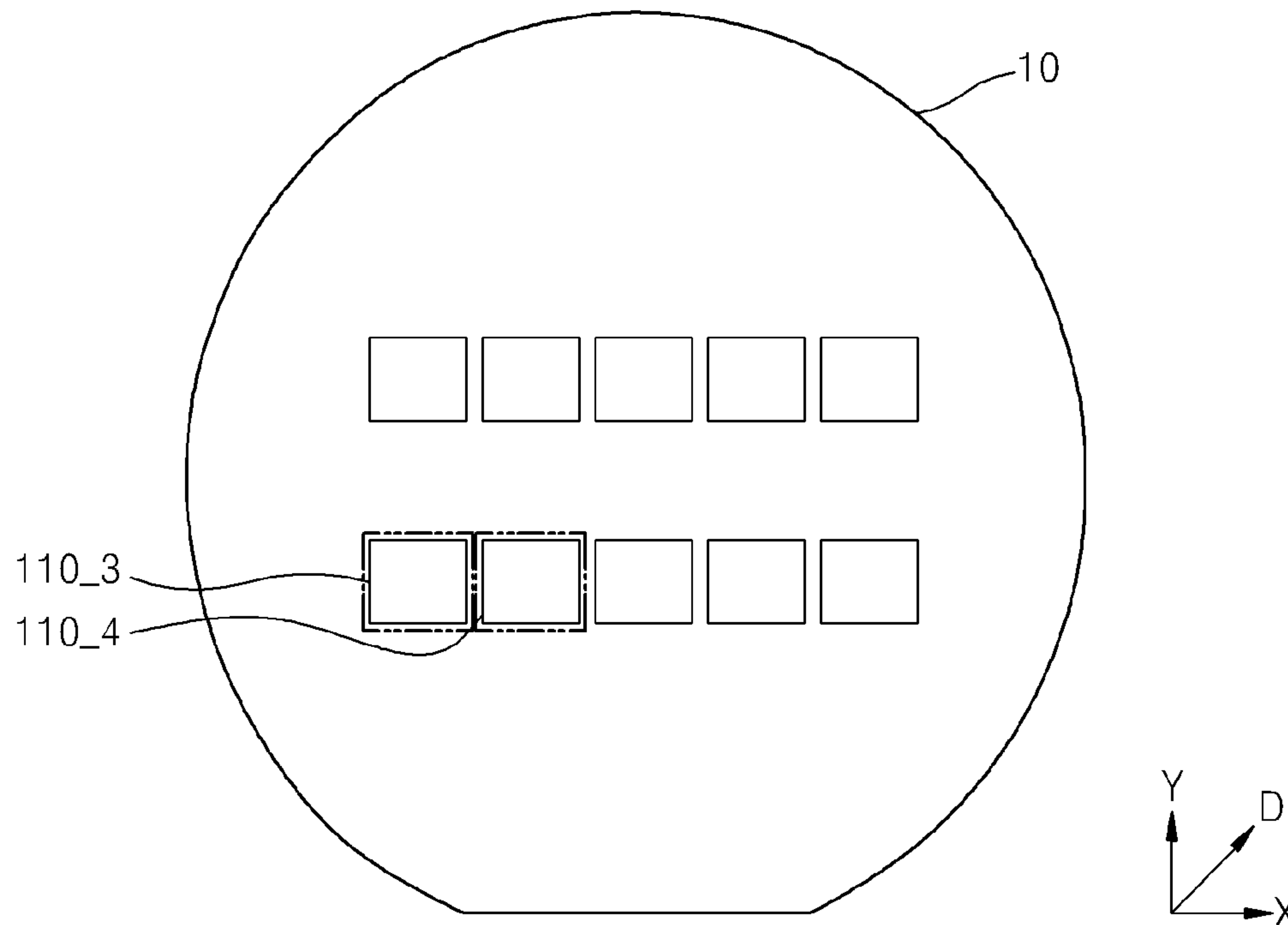


FIG. 13

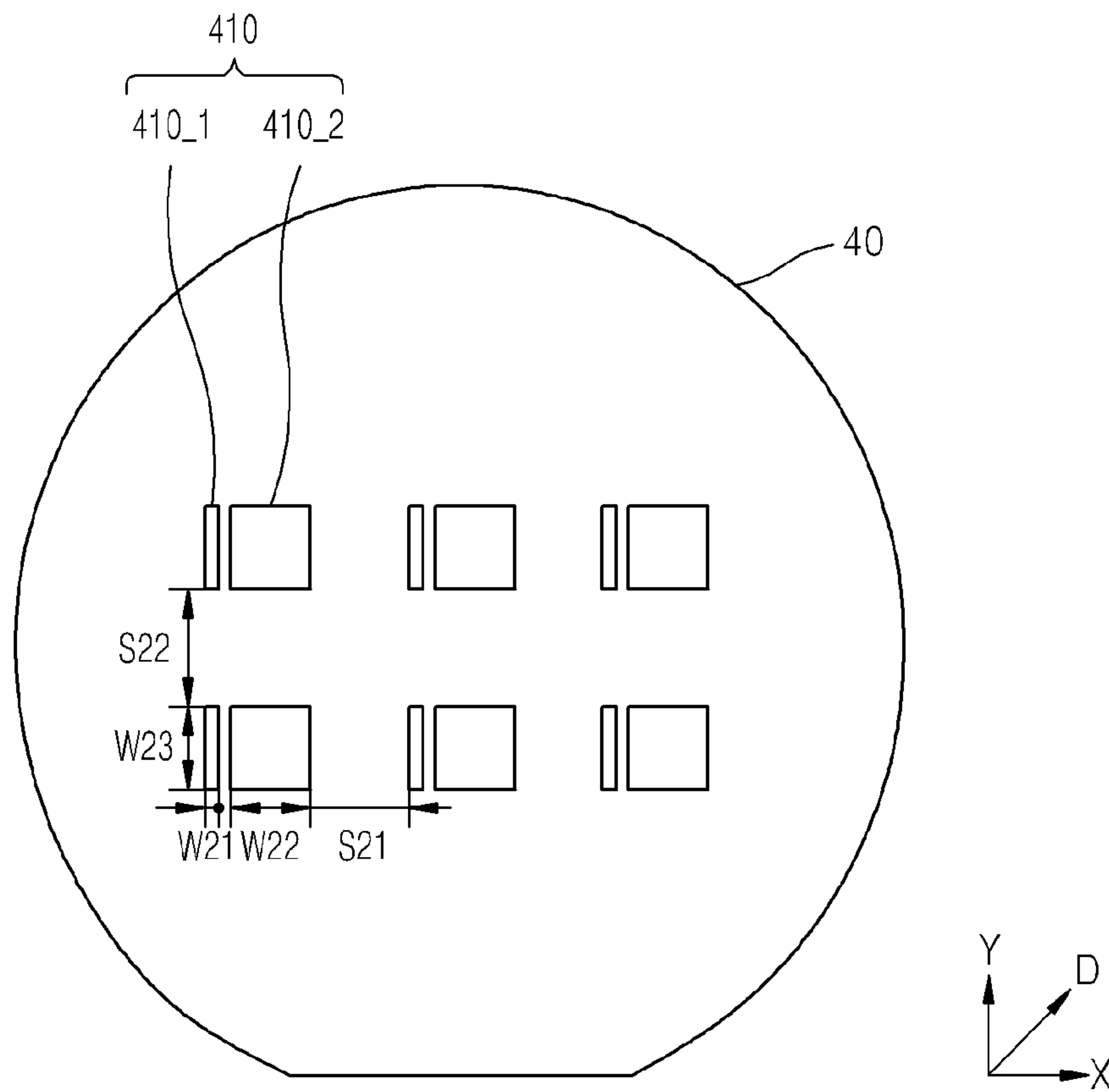


FIG. 14

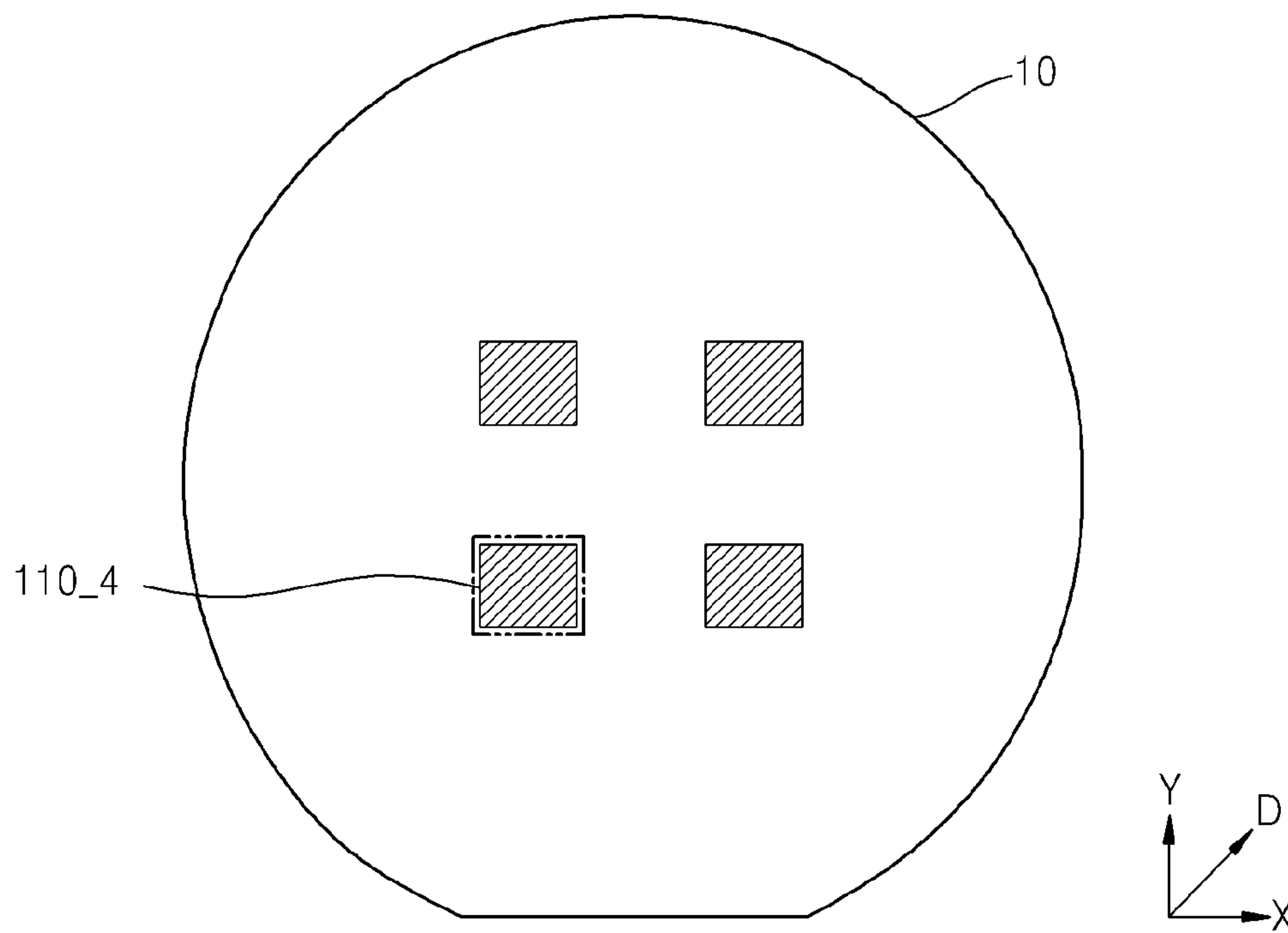


FIG. 15

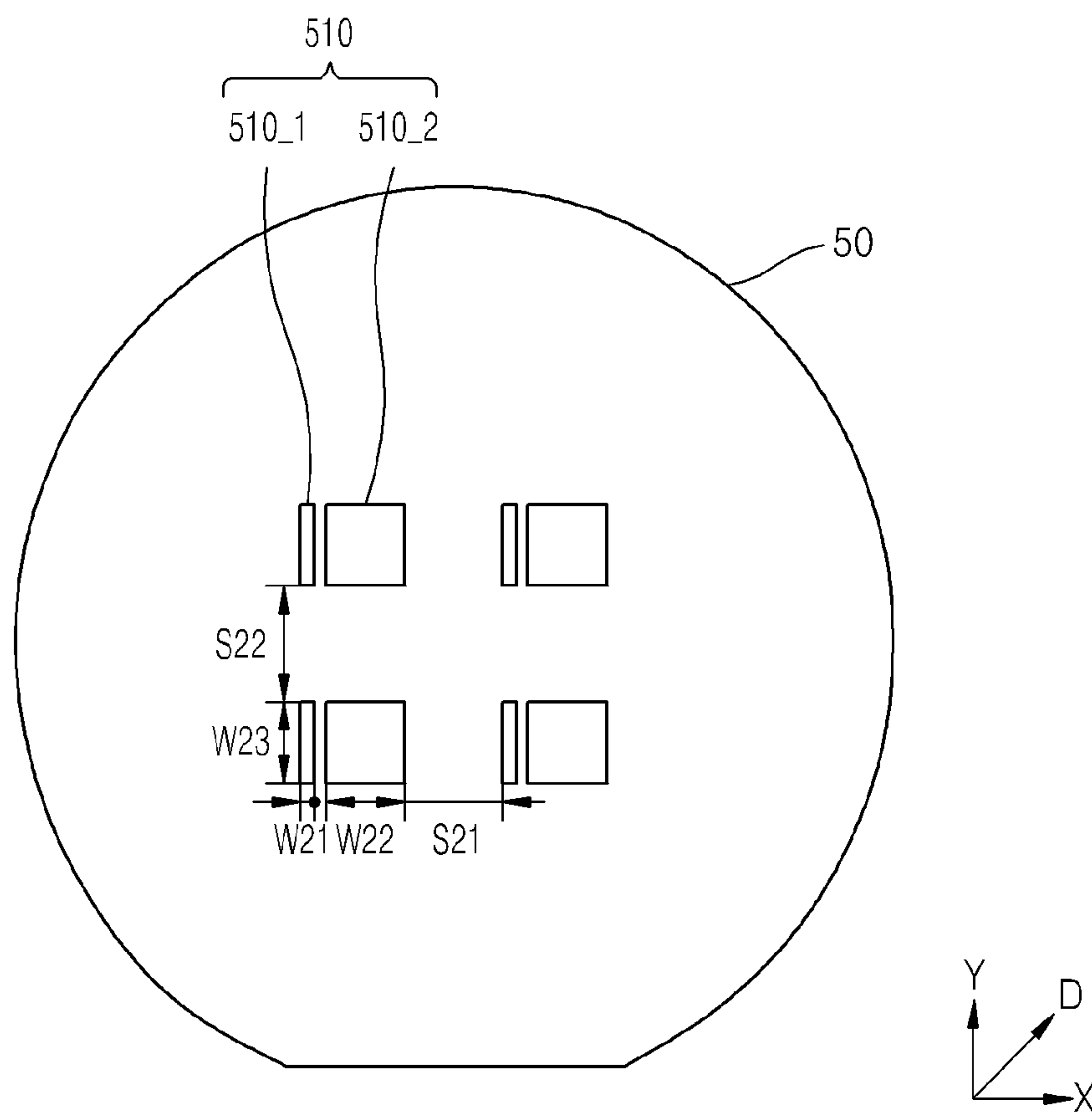


FIG. 16A

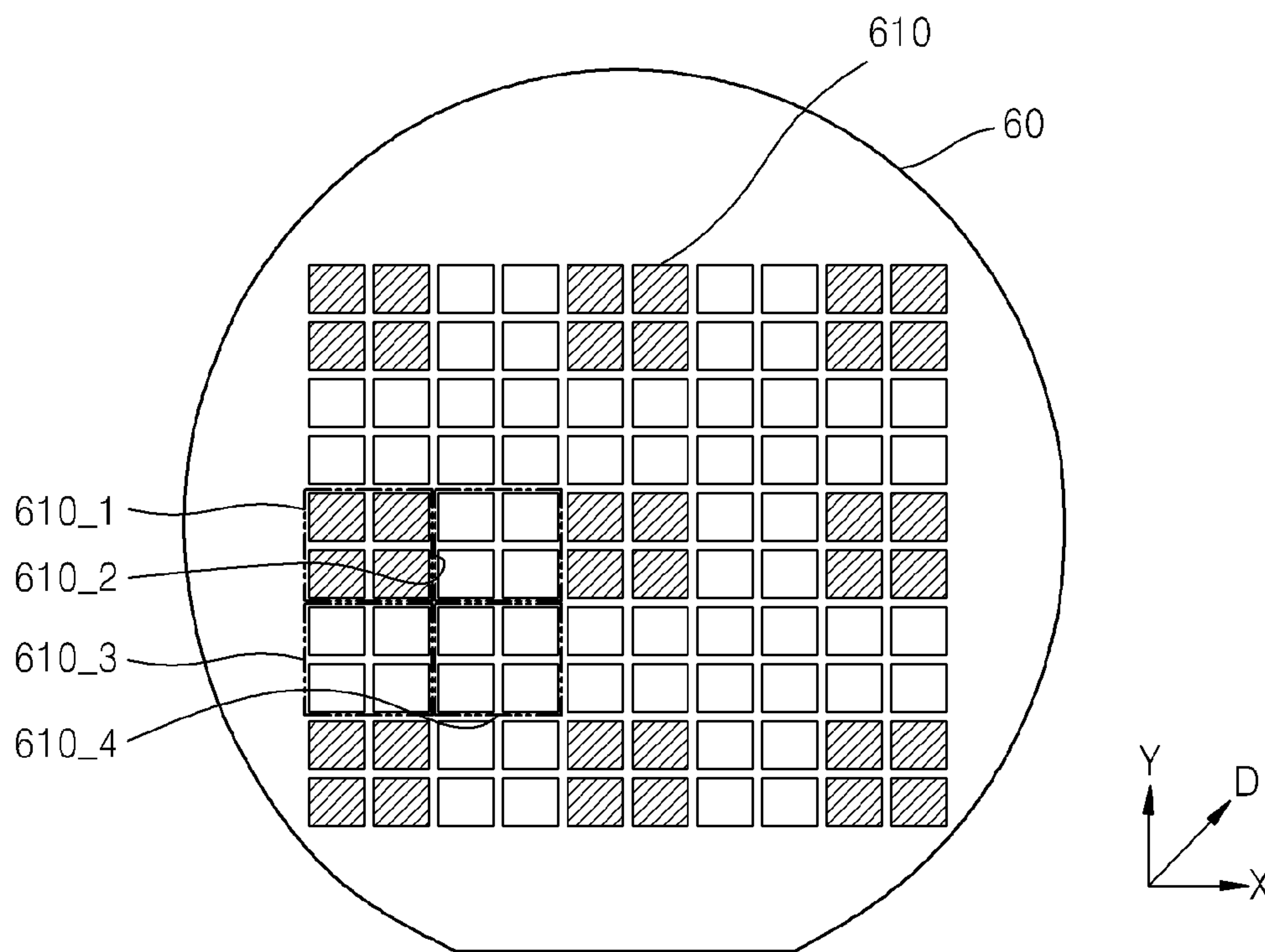


FIG. 16B

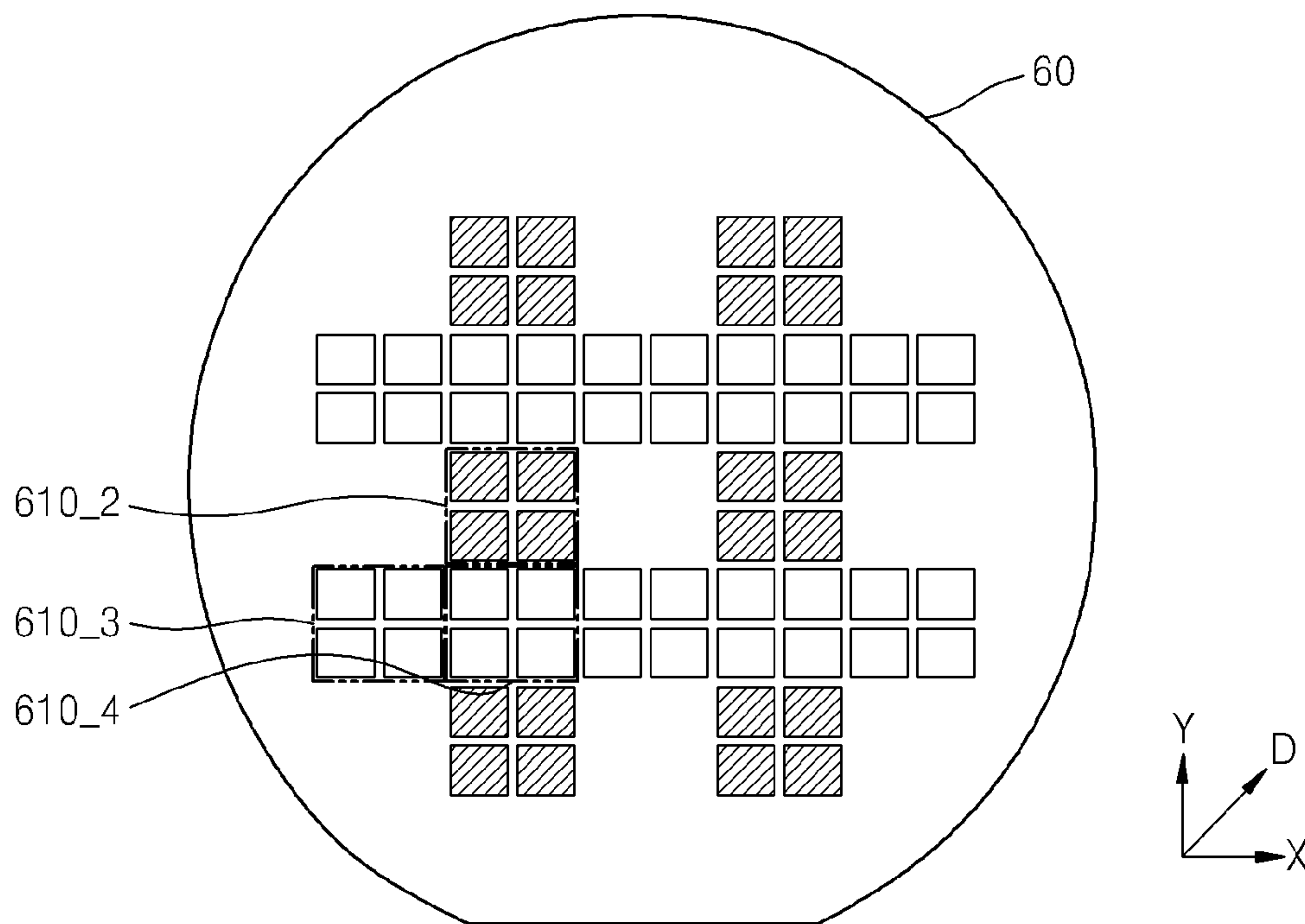


FIG. 16C

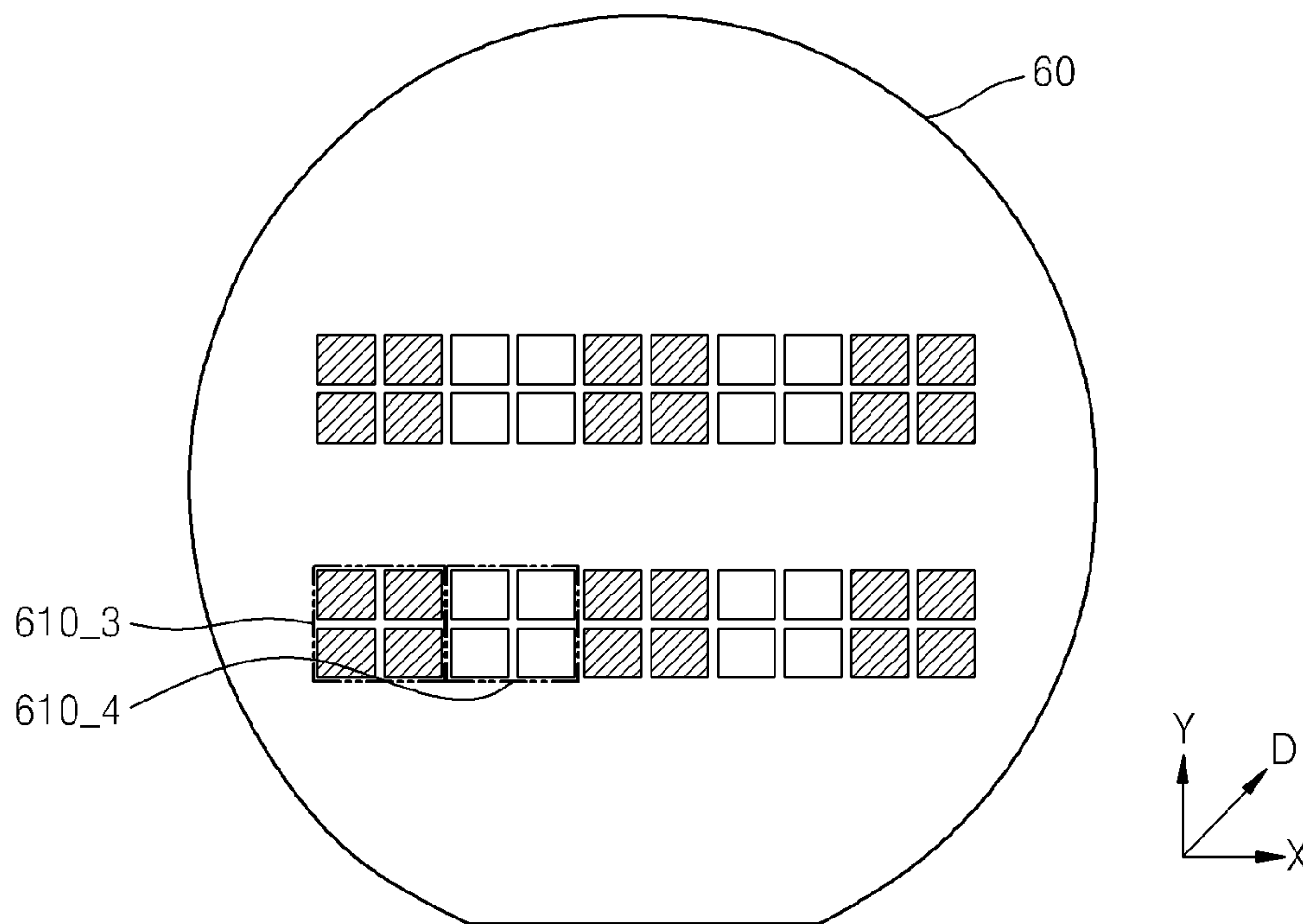




FIG. 16D

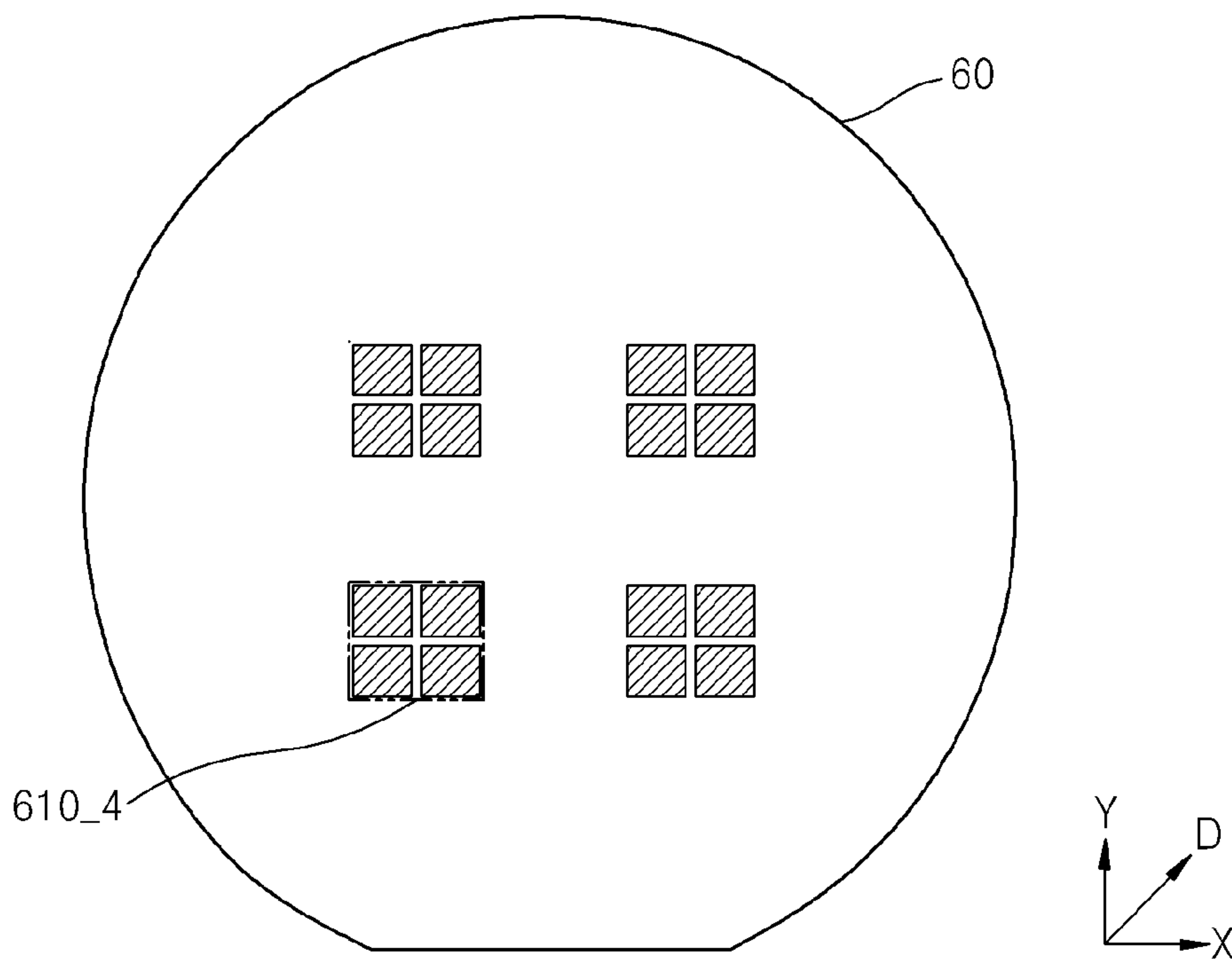


FIG. 17A

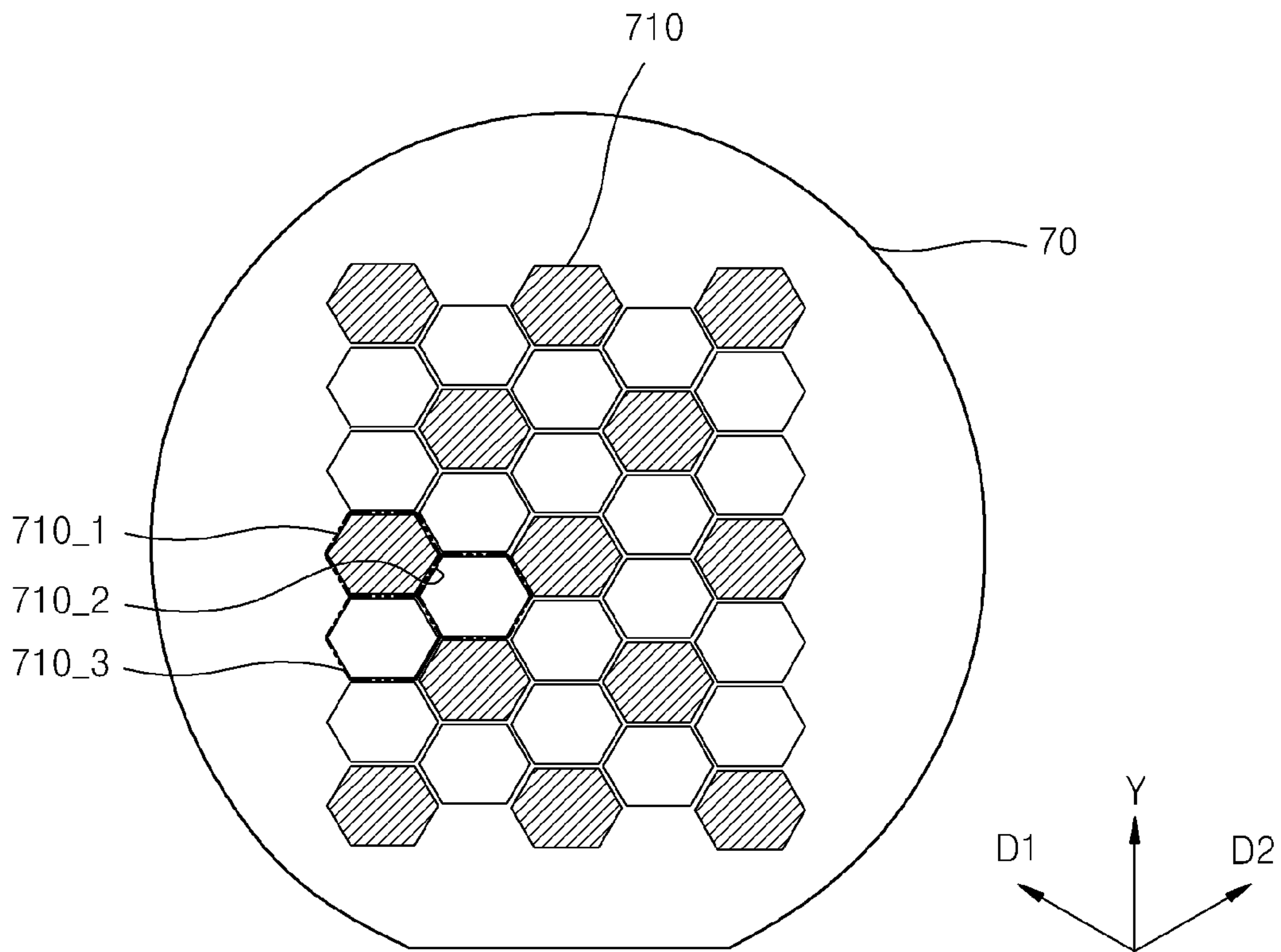


FIG. 17B

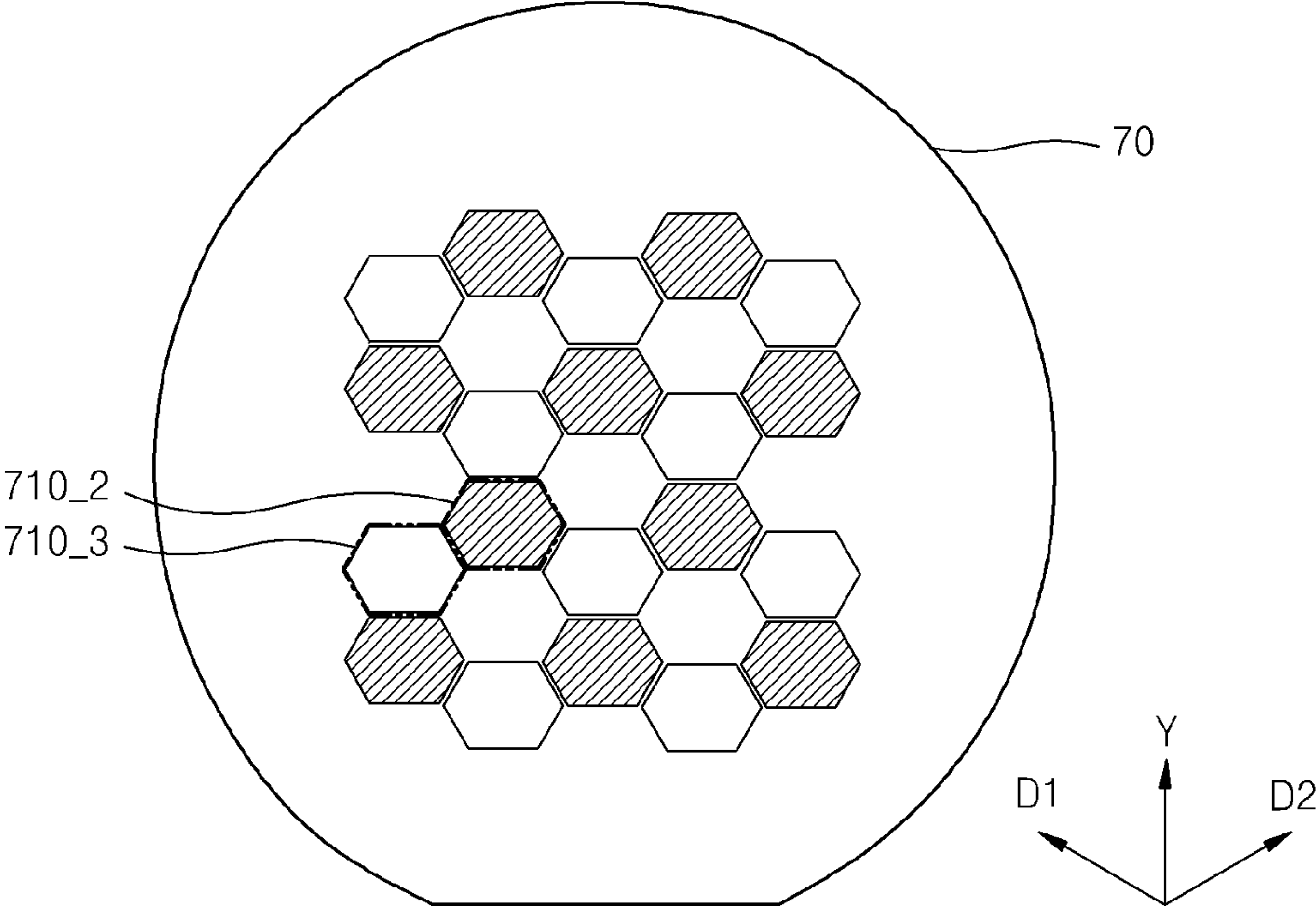
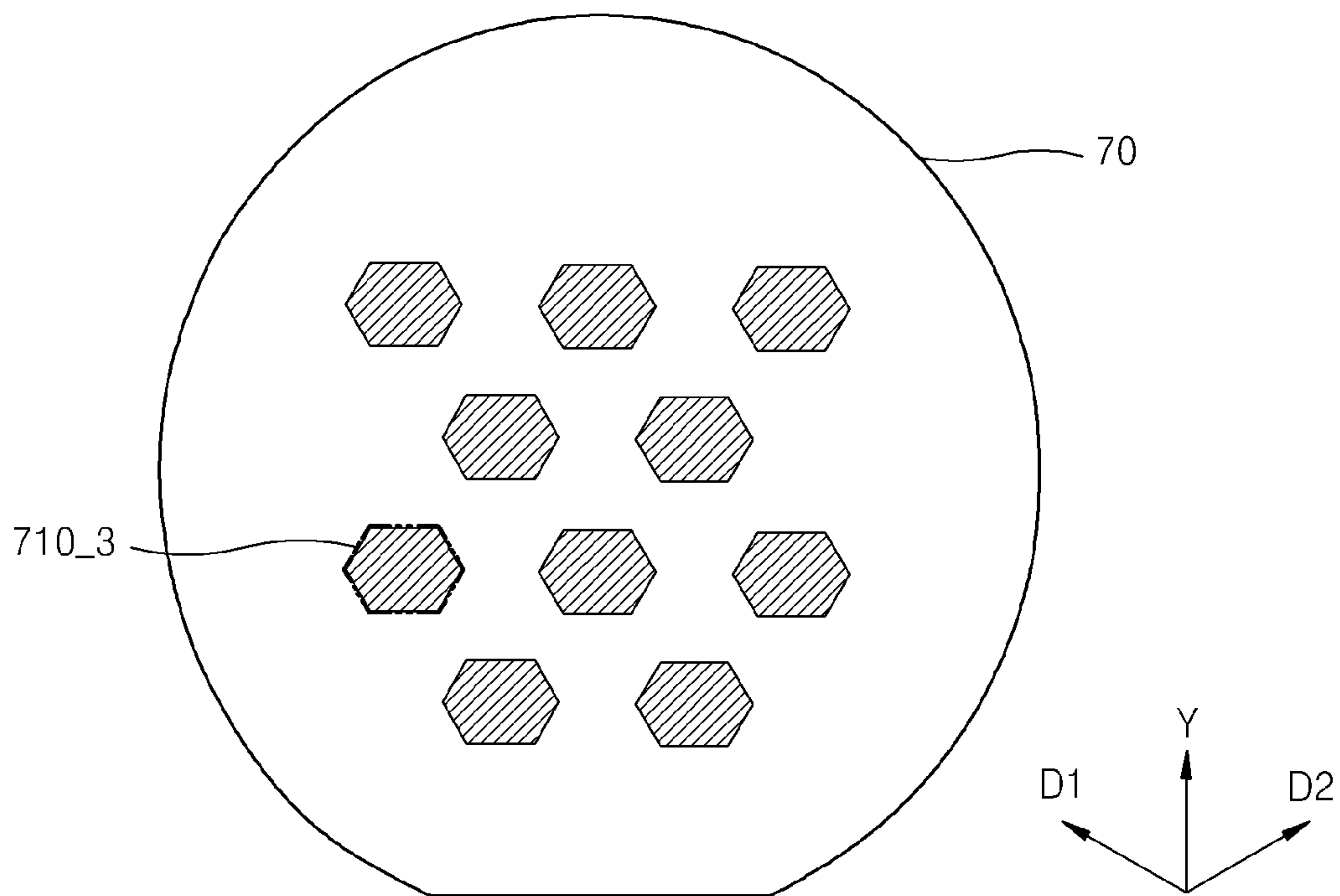


FIG. 17C





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## METHOD FOR MANUFACTURING LIGHT EMITTING DEVICE PACKAGE

### CROSS-REFERENCE TO RELATED APPLICATION

This application claims the benefit of Korean Patent Application No. 10-2013-0008633, filed on Jan. 25, 2013, in the Korean Intellectual Property Office, the disclosure of which is incorporated herein in its entirety by reference.

### TECHNICAL FIELD

The inventive concept relates to a method for manufacturing a light emitting device package, and more particularly, to a method for manufacturing a light emitting device package, which is simple in its process, and can be manufactured in a chip scale package at a wafer level.

### BACKGROUND

A Light Emitting Diode (LED) is a light emitting device that changes electrical signals into light through a PN junction of compound semiconductors. Since LEDs can be damaged by external physical or chemical shocks, LEDs are implemented in a package to be used in various fields such as indoor/outdoor illumination, vehicle headlights, Back-Light Units (BLU), and medical appliances. Recently, a process of manufacturing a light emitting device package has become more complicated and difficult due to demands for high output and high efficiency of light emitting device packages.

### SUMMARY

The disclosure provides a method for manufacturing a light emitting device package, which enables yield improvement and process automation.

According to an aspect of the disclosure, a method of manufacturing a light emitting device package is provided. The method includes preparing a growth substrate including a plurality of light emitting devices disposed on a top surface of the growth substrate, and preparing a first package substrate having a bonding pattern corresponding to a portion of the plurality of light emitting devices, the bonding pattern being formed on a top surface of the first package substrate. The portion of the plurality of light emitting devices and the bonding pattern are bonded by disposing the top surface of the growth substrate to face the top surface of the first package substrate. The portion of the plurality of light emitting devices are separated from the growth substrate, and the portion of the plurality of light emitting devices joined to the bonding pattern are packaged.

In certain other embodiments of the disclosure, the portion of the plurality of light emitting devices may be spaced apart from one another by at least one light emitting device.

In certain embodiments, the portion of the plurality of light emitting devices may be divided into groups including at least two light emitting devices that are adjacent to each other, and the groups may be spaced apart from one another by at least one group.

In certain embodiments, the bonding pattern may include a first conductive region and a second conductive region, and the bonding of the portion of the plurality of light emitting devices and the bonding pattern may include bonding the portion of the plurality of light emitting devices and the bonding pattern so that the portion of the plurality of light

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emitting devices overlap at least a portion of the first conductive region and the second conductive region.

In certain embodiments, the separating of the portion of the plurality of light emitting devices may include selectively performing a laser lift-off on the portion of the plurality of light emitting devices.

In certain embodiments, the packaging of the portion of the plurality of light emitting devices may further include: forming, over the first package substrate and lens units surrounding the portion of the plurality of light emitting devices, respectively; and cutting the first package substrate to form units from the portion of the plurality of light emitting devices, wherein each of the units includes one of the plurality of light emitting devices and one of the lens units.

In certain embodiments, the method may further include: preparing a second package substrate having a bonding pattern corresponding to a portion of the plurality of light emitting devices remaining in the growth substrate, formed on a top surface of the growth substrate; bonding the portion of the plurality of light emitting devices remaining on the growth substrate and the bonding pattern of the second package substrate by disposing the top surface of the growth substrate and a top surface of the second package substrate to face each other; and separating the portion of the plurality of light emitting devices bonded to the bonding pattern of the second package substrate from the growth substrate.

In certain embodiments, the first package substrate and the second package substrate may be separate from each other.

According to another aspect of the disclosure, there is provided a method of manufacturing a light emitting device package, including: preparing a growth substrate including a plurality of light emitting device groups disposed on a top surface of the growth substrate. A first package substrate is prepared having a first bonding pattern corresponding to first light emitting device groups that are not adjacent to one another among the plurality of light emitting device groups, the first bonding pattern being disposed on a top surface of the first package substrate. The first light emitting device groups and the first bonding pattern are bonded by disposing the top surface of the growth substrate to face the top surface of the first package substrate. The first light emitting device groups from the growth substrate are separated. A second package substrate is prepared having a second bonding pattern corresponding to second light emitting device groups that are not adjacent to one another among the plurality of light emitting device groups remaining in the growth substrate. The second bonding pattern being formed on a top surface of the growth substrate. The second light emitting device groups and the second bonding pattern are bonded by disposing the top surface of the growth substrate to face the top surface of the second package substrate, and the second light emitting device groups are separated from the growth substrate.

In certain embodiments of the disclosure, each of the plurality of light emitting device groups may include at least two light emitting devices that are adjacent to each other.

In certain embodiments, the plurality of light emitting device groups may be arranged to form a matrix shape on the top surface of the growth substrate.

In certain embodiments, the first light emitting device group and the second light emitting device group may be spaced apart from each other by at least one light emitting device group in row and column directions

In certain embodiments, the plurality of light emitting device groups may be arranged to form a honeycomb shape on the top surface of the growth substrate.

In certain embodiments, the first light emitting device group and the second light emitting device group may be



spaced apart from each other by at least one light emitting device group in row and diagonal directions.

In certain embodiments, the method may further include: forming lens units over the first package substrate for surrounding the light emitting devices of the first light emitting device group, forming the lens units over the second package substrate for surrounding the light emitting devices of the second light emitting device group. The first package substrate is cut to form units from the first light emitting device group, wherein each of the units includes one of the light emitting devices of the first light emitting device group and one of the lens units; and cutting the second package substrate to form units from the second light emitting device group, wherein each of the units includes one of the light emitting devices of the second light emitting device group and one of the lens units.

According to another aspect of the disclosure, a method of manufacturing a light emitting device package is provided. The method comprises preparing a growth substrate comprising a plurality of first light emitting devices and a plurality of second light emitting devices disposed on a top surface of the growth substrate. A first package substrate is prepared having a first bonding pattern corresponding to the plurality of first light emitting devices, the bonding pattern being disposed on a top surface of the first package substrate, wherein a top surface of the bonding pattern extends above the top surface of the first package substrate. The plurality of the first light emitting devices and the first bonding pattern are bonded by disposing the top surface of the growth substrate to face the top surface of the first package substrate and applying sufficient heat to bond the first light emitting devices to the first bonding pattern. The plurality of first light emitting devices are separated from the growth substrate. A lens is formed surrounding each of the plurality of first light emitting devices, and portions of the first package substrate are separated from each other, wherein each portion contains a light emitting device.

In certain embodiments, each of the first light emitting devices are spaced apart from each other by at least one other light emitting device in row, column, and diagonal directions on the growth substrate.

In certain embodiments, the first plurality of light emitting devices are separated by selectively performing a laser lift-off on the plurality of first light emitting devices.

In certain embodiments, a second package substrate is prepared having a second bonding pattern corresponding to the plurality of second light emitting devices, the bonding pattern being disposed on a top surface of the second package substrate, wherein a top surface of the bonding pattern extends above the top surface of the second package substrate. The plurality of the second light emitting devices and the second bonding pattern are bonded by disposing the top surface of the growth substrate to face the top surface of the second package substrate and applying sufficient heat to bond the second light emitting devices to the second bonding pattern. The plurality of second light emitting devices are separated from the growth substrate. A lens surrounding each of the plurality of second light emitting devices is formed, and portions of the second package substrate are separated from each other, wherein each portion contains a light emitting device.

In certain embodiments, the portions of the first package substrate are separated from each other by cutting the first package substrate.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Exemplary embodiments of the disclosure will be more clearly understood from the following detailed description taken in conjunction with the accompanying drawings.

FIGS. 1A through 15 are views illustrating a process sequence for explaining a method for manufacturing a light emitting device package according to certain embodiments of the disclosure, in which FIGS. 1A, 2A, 7A, 8A, 12, and 14 are plan views illustrating planar views of shapes of certain components, and FIGS. 1B, 2B, 3 to 6, 7B, 8B, 9 to 11, 13, and 15 are side cross-sectional views illustrating cross-sectional views of shapes of certain components.

FIGS. 16A through 16D are plan views illustrating planar shapes of a growth substrate based on the order of the light emitting devices being mounted on a package substrate according to certain other embodiments of the disclosure.

FIGS. 17A through 17C are plan views illustrating planar shapes of a growth substrate based on the order of the light emitting devices being mounted on a package substrate according to certain other embodiments of the disclosure.

#### DETAILED DESCRIPTION OF THE EMBODIMENTS

As used herein, the term “and/or” includes any and all combinations of one or more of the associated listed items. Expressions such as “at least one of”, when preceding a list of elements, modify the entire list of elements and do not modify the individual elements of the list.

Hereinafter, exemplary embodiments of the inventive concept will be described in detail with reference to the accompanying drawings. Like reference numerals in the drawings denote like elements, and thus their description will be omitted.

The inventive concept may, however, be embodied in many different forms and should not be construed as being limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the inventive concept to those skilled in the art.

Also, though terms like a first and a second are used to describe various members, components, regions, layers, and/or portions in various embodiments of the inventive concept, the members, components, regions, layers, and/or portions are not limited to these terms. These terms are used only to differentiate one member, component, region, layer, or portion from another one. Therefore, a member, a component, a region, a layer, or a portion referred to as a first member, a first component, a first region, a first layer, or a first portion in an embodiment can be referred to as a second member, a second component, a second region, a second layer, or a second portion in another embodiment. For example, a first component can be referred to as a second component, and similarly, the second component can be referred to as the first component.

Unless defined differently, all terms used herein include technical terms and scientific terms, and have the same meanings as understood in common by those skilled in the art to which the inventive concept pertains. Also, terms as defined in dictionaries, being generally used, should be construed as having the consistent meanings in the context of the related technology, and should not be construed as excessively formal meanings unless explicitly defined herein.

When any embodiment can be implemented in different ways, a specific process order can also be performed differently from the order described herein. For example, two processes described sequentially can also be performed at the substantially same time, and can also be performed in the order opposite to the order described herein.

In the accompanying drawings, for example, modifications of described shapes can be expected according to the manu-



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facturing technology. Therefore, embodiments of the inventive concept should not be construed as being limited to a specific shape shown in this specification, and for example, should include variations of the shape incurred in the manufacturing processes.

FIGS. 1A through 15 are views illustrating a process sequence for explaining a method for manufacturing a light emitting device package according to certain embodiments of the disclosure, in which FIGS. 1A, 2A, 7A, 8A, and 12 to 17C are plan views illustrating planar views of shapes of certain components, and FIGS. 1B, 2B, 3 to 6, 7B, 8B, and 9 to 11 are side cross-sectional views illustrating cross-sectional views of shapes of certain components.

FIG. 1A is a plan view illustrating a main part of a growth substrate 10 according to certain embodiments of the disclosure. FIG. 1B is a cross-sectional view taken along line I-I' of FIG. 1A. For convenience of explanation, only five light emitting devices are shown as formed in each row and column in FIGS. 1A and 1B, but the disclosure is not limited thereto.

Referring to FIGS. 1A and 1B, the growth substrate 10 in which a plurality of light emitting devices 110 are formed on a top surface thereof is prepared.

The plurality of light emitting devices 110 may be sequentially arranged along the row direction (X-direction) and the column direction (Y-direction) so as to form a matrix shape on the top surface of the growth substrate 10. The plurality of light emitting devices 110 may form a matrix shape in which first light emitting devices 110\_1 disposed at the left top of a unit, second light emitting devices 110\_2 adjacent thereto in the row direction (X-direction), third light emitting devices 110\_3 adjacent thereto in the column direction (Y-direction), and fourth light emitting devices adjacent thereto in the diagonal direction are repeatedly arranged. As described later, the first to fourth light emitting devices 110\_1 to 110\_4 may be sequentially mounted on first to fourth package substrates (see 20 to 50 of FIGS. 2A to 15), respectively. However, the mounting order is not limited thereto, but the first to fourth light emitting devices 110\_1 to 110\_4 may be mounted in the corresponding first to fourth package substrates 20 to 50 in various orders. For example, the first light emitting devices 110\_1, the third light emitting devices 110\_3, the second light emitting devices 110\_2, and the fourth light emitting devices 110\_4 may also be sequentially mounted in their corresponding package substrates. Hereinafter, it will be noted that light emitting devices mounted in corresponding package substrates are shaded in the accompanying drawings for convenience of explanation.

The plurality of light emitting devices 110 may have a first width W11 in the row direction (X-direction) and a second width W12 in the column direction (Y-direction). The first and second widths W11 and W12 may vary in size according to required device characteristics and process conditions. In FIG. 1, the plurality of light emitting devices 110 are shown as having the same area, e.g., the substantially same first width W11 and second width W12, but the disclosure is not limited thereto. The plurality of light emitting devices 110 may each have a different area. Hereinafter, the plurality of light emitting devices 110 will be illustrated as each having the first width W11 and second width W12 of the substantially same size for convenience of explanation.

The plurality of light emitting devices 110 may be arranged so as to be spaced apart from one other by a first gap S11 in the row direction (X-direction) and a second gap S12 in the column direction (Y-direction). The first gap S11 and the second gap S12 may be formed to have a minimum size to reduce a loss of the growth substrate 10. Hereinafter, the first

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gap S11 and the second gap S12 will be illustrated as having the substantially same size for convenience of explanation.

In certain embodiments, the plurality of light emitting devices 110 may be formed by growing each semiconductor layer on the top surface of the growth substrate 10 through a process such as Metal Organic Chemical Vapor Deposition (MOCVD), Molecular Beam Epitaxy (MBE), or Hybrid Vapor Phase Epitaxy (HVPE) and then individually separating the semiconductor layers through dicing.

In certain embodiments, the growth substrate 10 may be an insulating substrate that has good deposition characteristics due to a crystal lattice constant similar to that of the semiconductor layer constituting the light emitting device 110. For example, the growth substrate 10 may be a sapphire ( $\text{Al}_2\text{O}_3$ ) substrate, a spinel ( $\text{MgAl}_2\text{O}_4$ ) substrate, a silicon carbide (SiC) substrate, or a gallium nitride (GaN) substrate.

In certain embodiments, the growth substrate 10 may have an unevenness (not shown) formed in the whole of the top surface thereof or in an interface between the plurality of light emitting devices 110.

In certain embodiments, the plurality of light emitting devices 110 may be formed of Light Emitting Diode (LED) chips. The LED chips may emit light such as blue light, green light, and red light according to the types of the compound semiconductor. Alternatively, the LED chips may emit ultraviolet rays. In certain other embodiments, the plurality of light emitting devices 110 may be formed of a UV ray diode chip, a laser diode chip, or an organic light emitting diode. However, according to the disclosure, the plurality of light emitting devices 110 are not limited to those exemplified above, but may be configured with various types of optical device.

In certain embodiments, each of light emitting devices 110 may adopt a flip chip structure, a vertical electrode structure, or a vertical horizontal electrode structure. Hereinafter, although not shown in FIGS. 1A and 1B, each of light emitting devices 110 will be illustrated as having a flip chip structure including an electrode formed on the top surface thereof.

FIG. 2A is a plan view illustrating a main part of a first package substrate 20 according to certain embodiments of the disclosure. FIG. 2B is a cross-sectional view taken along line II-II' of FIG. 2A. For convenience of explanation, three bonding patterns are shown as being formed in each row and column in FIGS. 2A and 2B, but embodiments are not limited thereto. For example, the bonding patterns may be further formed in each row and column according to the number of corresponding light emitting devices.

Referring to FIGS. 1A to 2B, a first package substrate 20 having first bonding patterns 210 formed on the top surface thereof is prepared.

The first bonding patterns 210 may each include a first conductive region 210\_1 and a second conductive region 210\_2, and the first bonding patterns 210 may be formed at locations corresponding to the first light emitting devices 110\_1 disposed on the growth substrate 10. Specifically, for each of the first bonding patterns 210, the first conductive region 210\_1 and the second conductive region 210\_2 may be formed at a location where at least a portion of the first conductive region 210\_1 and the second conductive region 210\_2 overlaps a corresponding first light emitting device 110\_1 so as to bond electrodes of the corresponding first light emitting device 110\_1 in a subsequent bonding process (see FIG. 3). Thus, in the subsequent bonding process, only the first light emitting devices 110\_1 that are not adjacent to each other among the plurality of light emitting devices 110 on the growth substrate 10 and are spaced apart from one other by at



least one light emitting device in the row direction (X-direction), the column direction (Y-direction), and the diagonal direction (D-direction) may be mounted in the first package substrate **20**.

The first conductive region **210\_1** may have a third width **W21** in the row direction (X-direction) and a fourth width **W23** in the column direction (Y-direction), and the second conductive region **210\_2** may have a fifth width **W22** in the row direction (X-direction) and the fourth width **W23** in the column direction (Y-direction). The sizes of the third width **W21** to the fifth width **W22** may be variously set such that at least a portion of the corresponding first conductive region **210\_1** and second conductive region **210\_2** can overlap the first light emitting device **110\_1**.

The sizes of the third width **W21** to the fifth width **W22** may be set so as not to overlap the first light emitting devices **110\_1** and light emitting devices adjacent thereto in the row direction (X-direction), the column direction (Y-direction), and the diagonal direction (D-direction) at the same time.

In certain embodiments, the sizes of the third width **W21** to the fifth width **W22** may also be set so as to overlap the first light emitting devices **110\_1** and light emitting devices adjacent thereto in the row direction (X-direction), the column direction (Y-direction), and the diagonal direction (D-direction). However, in this case, an intermediate layer (not shown) needs to be disposed under the first conductive region **210\_1** and the second conductive region **210\_2**, or the first conductive region **210\_1** and the second conductive region **210\_2** need to be formed to have a step in a vertical direction such that the first light emitting device **110\_1** and the light emitting devices adjacent thereto do not join with the first conductive region **210\_1** and the second conductive region **210\_2**. The intermediate layer may be formed of the same material as the corresponding conductive region, but embodiments are not limited thereto.

Meanwhile, the third width **W21** and the fifth width **W22** are shown as having different sizes in FIGS. 2A and 2B, but the disclosure is not limited thereto. Also, the first conductive region **210\_1** and the second conductive region **210\_2** are shown as having the fourth width **W23** of the same size in the column direction (Y-direction), but the disclosure is not limited thereto.

The first bonding patterns **210** may be formed to be spaced from one other by a third gap **S21** in the row direction and a fourth gap **S22** in the column direction (Y-direction). The third gap **S21** and the fourth gap **S22** may have the same or different sizes.

The first bonding patterns **210** may be formed such that the first conductive region **210\_1** and/or the second conductive region **210\_2** have a step of a vertical direction in accordance with the electrode structure of the first light emitting devices **110\_1**. Also, in FIG. 2B, the first bonding patterns **210** are shown as being formed in a single layer, but the disclosure is not limited thereto. For example, the first conductive region **210\_1** and the second conductive region **210\_2** of the first bonding patterns **210** may be implemented in a plurality of layers, respectively.

The first package substrate **20** may further include a first lower electrode **230\_1** and a second electrode **230\_2**, and through electrodes **220** that penetrate the first package substrate **20**. The first lower electrode **230\_1** and the second lower electrode **230\_2** may be respectively electrically connected to the first conductive region **210\_1** and the second conductive region **210\_2** through the through electrodes **220**. The first lower electrode **230\_1** and the second lower electrode **230\_2** may allow the first package substrate **20** to be

electrically connected to a Printed Circuit Board (PCB; not shown) or an external apparatus.

In certain embodiments, the first bonding patterns **210** may be formed by forming a metallic material film (not shown) with excellent electrical conductivity and joining characteristics by a process such as Chemical Vapor Deposition (CVD) or Physical Vapor Deposition (PVD) and then performing patterning by a photolithography or lift-off process. Alternatively, the first bonding patterns **210** may also be formed by a plating process. The metallic material film may be formed of a material such as Au, Sn, Pb, Ag, In, Ge, Si or a combination thereof. In certain embodiments the metallic material film is a low melting point material such as Au—Sn alloy, Ni—Sn alloy, or Cu—Sn alloy.

In certain embodiments, the first package substrate **20** may be an insulating substrate. For example, the first package substrate **20** may be a silicon substrate, a ceramic substrate, an aluminum nitride (AlN) substrate, a sapphire (Al<sub>2</sub>O<sub>3</sub>) substrate, or an FR4 substrate.

FIG. 3 is a cross-sectional view illustrating a step of bonding the first light emitting devices **110\_1** and the first package substrate **20** according to certain embodiments of the disclosure.

Referring to FIGS. 1A to 3, the top surface of the growth substrate **10** may be disposed to face the top surface of the first package substrate **20** such that the first light emitting devices **110\_1** of the plurality of light emitting devices **110** face the first bonding pattern **210**. Thereafter, heat may be applied to bond the first and second electrodes (not shown) on the uppermost surface of the first light emitting devices **110\_1** with the first conductive region **210\_1** and the second conductive region **210\_2** of the first bonding pattern **210**.

FIG. 4 is a cross-sectional view illustrating a step of selectively separating the first light emitting devices **110\_1** from the growth substrate **10** according to certain embodiments of the disclosure.

Referring to FIG. 1A to 4, a laser beam may be selectively irradiated on interfaces between the first light emitting devices **110\_1** of the plurality of light emitting devices **110** and the growth substrate **10** from the bottom surface of the growth substrate **10** to separate the first light emitting devices **110\_1** from the growth substrate **10**. In FIG. 4, the first light emitting devices **110\_1** are shown as being selectively separated by a laser lift-off process, but the embodiments are not limited thereto. In certain embodiments, the first light emitting devices **110\_1** may be selectively separated by a chemical lift-off process.

Meanwhile, when an unevenness structure is not formed in the top surface of the substrate **10**, if necessary, an unevenness structure may be formed in the bottom surface of the first light emitting device **110\_1** by a photolithography process or an etching process to improve the light extraction efficiency of the light emitting device package.

FIG. 5 is a cross-sectional view illustrating a step of forming lens units **240** over the first light emitting devices **110\_1** on the first package substrate **20** according to certain embodiments of the disclosure.

Referring to FIGS. 1A to 5, the lens units **240** may be formed to surround the first light emitting devices **110\_1** on the first package substrate **20**. The lens unit **240** may be formed to surround the entire first bonding pattern **210**. However, the disclosure is not limited thereto, and the lens unit **240** may also be formed such that a portion of the first conductive region **210\_1** and/or the second conductive region **210\_2** is exposed.

In certain embodiments, the inside of the lens unit **240** may be filled with silicon resin, epoxy resin, plastic, or glass. In



certain other embodiments, a refractive member (not shown) may also be included inside the lens unit **240**. The refractive member (not shown) may refract or reflect light emitted from the first light emitting devices **110\_1**. In certain other embodiments, the lens unit **240** may include a fluorescent substance (not shown). The fluorescent substance may include at least one of a yellow fluorescent substance, a green fluorescent substance, a red fluorescent substance, and a blue fluorescent substance.

FIG. **6** is a cross-sectional view illustrating a step of individually separating the first light emitting devices **110\_1** according to certain embodiments of the disclosure.

Referring to FIGS. **1** to **6**, a light emitting package **P1** may be formed by cutting the first package substrate **20** into units of the first light emitting devices **110\_1** modularized by the lens unit **240**.

In certain embodiments, a diamond sawing or laser cutting process may be used to cut off the first package substrate **20**.

FIG. **7A** is a plan view illustrating a main part of the growth substrate **10** according to certain embodiments of the disclosure, and FIG. **7B** is a cross-sectional view taken along line VII-VII'. FIGS. **7A** and **7B** illustrate a state after the first light emitting devices **110\_1** have been separated from the growth substrate **10** of FIGS. **1A** and **1B**. For explanation of FIGS. **7A** and **7B**, the same reference numerals as FIGS. **1A** and **1B** indicate the same members, and detailed descriptions thereof will be omitted herein to simplify the description.

Referring to FIGS. **7A** and **7B**, the growth substrate **10** is prepared, on which the second to fourth light emitting devices **110\_2** to **110\_4** of the plurality of light emitting devices remain, whereas the first light emitting devices **110\_1** of the plurality of light emitting devices have been separated from the growth substrate **10**.

The second light emitting devices **110\_2** may be light emitting devices arranged in the same row as the first light emitting devices **110\_1** separated from the growth substrate **10**. The second light emitting devices **110\_2** may be adjacent to the fourth light emitting devices **110\_4** in the column direction (Y-direction), and may be adjacent to the third light emitting devices **110\_3** in the diagonal direction (D-direction). As described later, the second light emitting devices **110\_2** of the second to fourth light emitting devices **110\_2** to **110\_4** may be first mounted in a second package substrate **30** (see FIGS. **8A** to **11**), but this is merely for convenience of explanation. In other embodiments, the third light emitting devices **110\_3** or the fourth light emitting devices **110\_4** may also be preferentially mounted in each corresponding third package substrate **40** or fourth package substrate **50** (see FIGS. **12** to **15**).

FIG. **8A** is a plan view illustrating a main part of the second package substrate **30** according to certain embodiments of the disclosure. FIG. **8B** is a cross-sectional view taken along line VIII-VIII'. For explanation of FIGS. **8A** and **8B**, the same or similar reference numerals as FIGS. **2A** and **2B** indicate the same or similar members, and detailed descriptions thereof will be omitted herein to simplify the description.

Referring to FIGS. **7A** to **8B**, the second package substrate **30** having second bonding patterns **310** formed on the top surface thereof is prepared.

The second bonding patterns **310** may each include a first conductive region **310\_1** and a second conductive region **310\_2**, and the second bonding patterns **310** may be formed at locations corresponding to the second light emitting devices **110\_2** disposed on the growth substrate **10**. Specifically, for each of the second bonding patterns **310**, the first conductive region **310\_1** and the second conductive region **310\_2** may be formed at a location where at least a portion of the first

conductive region **310\_1** and the second conductive region **310\_2** overlaps a corresponding second light emitting device **110\_2** so as to bond electrodes of the corresponding second light emitting device **110\_2** in a subsequent bonding process (see FIG. **9**). Thus, in the subsequent bonding process, only the second light emitting devices **110\_2** that are not adjacent to each other among the plurality of light emitting devices on the growth substrate **10** and are spaced apart from one other by at least one light emitting device in the column direction (Y-direction) and the diagonal direction (D-direction) may be mounted in the second package substrate **30**.

Meanwhile, the second package substrate **30** may correspond to a separate substrate from the first package, and may be an insulating substrate formed of the same or different material as the first package substrate **20**. Also, the second package substrate **30** may have a configuration that corresponds to that of first package substrate **20**, although it may be different than the first package substrate **20**. For example, the second package substrate **30** may further include a first lower electrode **330\_1** and a second lower electrode **330\_2** disposed on the undersurface of the second package substrate **30**, and through electrodes **320** that penetrate the second package substrate **30** (FIG. **8b** is labeled differently with “**230\_1**” and “**230\_2**”).

FIG. **9** is a cross-sectional view illustrating a step of bonding the second light emitting devices **110\_2** and the second package substrate **30** according to certain embodiments of the disclosure, and FIG. **10** is a cross-sectional view illustrating a step of selectively separating the second light emitting devices **110\_2** from the growth substrate **10** according to certain embodiments of the disclosure. Also, FIG. **11** is a cross-sectional view illustrating a step of packaging the second light emitting devices **110\_2** according to certain embodiments of the disclosure. For explanation of FIGS. **9** to **11**, FIGS. **3** to **6** will be referred to. However, since reference numerals corresponding to those of FIGS. **3** to **6** indicate the same or corresponding members, detailed descriptions thereof will be omitted herein to simplify the description.

Referring to FIGS. **7A** to **11**, the top surface of the growth substrate **10** and the top surface of the first package substrate **20** (second package substrate **30**) may face each other to bond the light emitting devices **110\_2** with the second bonding pattern **310** on the top surface of the second package substrate **30**. Thereafter, the second light emitting devices **110\_2** may be selectively separated from the growth substrate **10**, and lens units **340** may then be formed to surround the second light emitting devices **110\_2** over the second package substrate **30**, respectively. Then, a light emitting device package **P2** may be formed by cutting the second package substrate **30** into units of second light emitting devices **110\_2** modularized by the lens unit **340**.

FIG. **12** is a plan view illustrating a main part of the growth substrate **10** according to certain embodiments of the disclosure, and illustrates a state after the second light emitting devices **110\_2** have been separated from the growth substrate **10** of FIGS. **7A** and **7B**. For explanation of FIG. **12**, the same reference numerals as FIGS. **7A** and **7B** indicate the same members, and detailed descriptions thereof will be omitted herein to simplify the description.

Referring to FIG. **12**, the growth substrate **10** is prepared, on which the third and fourth light emitting devices **110\_3** and **110\_4** of the plurality of light emitting devices remain, whereas the first and second light emitting devices **110\_1** and **110\_2** of the plurality of light emitting devices have been separated from the growth substrate **10**.

The third light emitting devices **110\_3** may be adjacent to the fourth light emitting device **110\_4** in the row direction



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(X-direction). As described later, the third light emitting devices **110\_3** of the third and fourth light emitting devices **110\_3** and **110\_4** may be first mounted in a third package substrate **40** (see FIG. **13**), but this is merely for convenience of explanation. In other embodiments, the fourth light emitting devices **110\_4** may also be preferentially mounted in the corresponding fourth package substrate **50** (see FIGS. **14** to **15**).

FIG. **13** is a plan view illustrating a main part of a third package substrate **40** according to certain embodiments of the disclosure. For explanation of FIG. **13**, reference numerals corresponding to those of FIGS. **8A** and **8B** indicate the same or corresponding members, and detailed descriptions thereof will be omitted herein to simplify the description.

Referring to FIGS. **12** and **13**, the third package substrate **40** having third bonding patterns **410** formed on the top surface thereof is prepared.

The third bonding patterns **410** may each include a first conductive region **410\_1** and a second conductive region **410\_2**, and the third bonding patterns **410** may be formed at locations corresponding to the third light emitting devices **110\_3** disposed on the growth substrate **10**. Specifically, for each of the third bonding patterns **410**, the first conductive region **410\_1** and the second conductive region **410\_2** may be formed at a location where at least a portion of the first conductive region **410\_1** and the second conductive region **410\_2** overlaps a corresponding third light emitting device **110\_3** so as to bond electrodes of the corresponding third light emitting device **110\_3** in a subsequent joining process. Thus, in the subsequent bonding process, only the third light emitting devices **110\_3** that are not adjacent to each other among the plurality of light emitting devices on the growth substrate **10** and are spaced apart from one other by at least one light emitting device in the row direction (X-direction) may be mounted in the third package substrate **40**.

Thus, similar to the manufactured light emitting device packages of FIGS. **3** to **6** or FIGS. **9** to **11**, light emitting device packages including the third light emitting devices **110\_3** can be manufactured by separating only the third light emitting devices **110\_3** from the growth substrate **10**, mounting the third light emitting devices **110\_3** in the third package substrate **40**, and then performing subsequent processes.

FIG. **14** is a plan view illustrating a main part of the growth substrate **10** according to certain embodiments of the disclosure, and illustrates a state after the third light emitting devices **110\_3** have been separated from the growth substrate **10** of FIG. **12**. FIG. **15** is a plan view illustrating a main part of a fourth package substrate **50** according to certain embodiments of the disclosure.

Referring to FIGS. **14** and **15**, the fourth light emitting devices **110\_4** that finally remain in the growth substrate **10** may be mounted in the fourth package substrate **50**.

Similar to the manufactured light emitting device packages of FIGS. **3** to **6** or FIGS. **9** to **11**, the fourth light emitting devices **110\_4** may be mounted in the fourth package substrate **50**, and then the fourth light emitting devices **110\_4** may be separated from the growth substrate **10**. Thereafter, light emitting device packages including the fourth light emitting devices **110\_4** can be manufactured through subsequent processes.

As described with reference to FIGS. **1A** to **15**, a method for manufacturing a light emitting device package according to an embodiment of the disclosure may include mounting, onto the first package substrate **20**, only the first light emitting devices **110\_1** that are not adjacent to each other among the plurality of light emitting devices **110** on the growth substrate **10**, forming the lens units **240** respectively surrounding each

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of the first light emitting devices **110\_1** over the first package substrate **20**, and performing separation for each of first light emitting devices **110\_1**. Similarly, the light emitting device packages including the respective light emitting devices can be manufactured by mounting the second to fourth light emitting devices **110\_2** to **110\_4** that are not adjacent to each other onto the second to fourth package substrates **30** to **50**, respectively, and performing subsequent processes.

Thus, a gap between light emitting devices can be sufficiently secured, enabling the formation of the lens unit and the individual separation process to be more easily and accurately performed. Also, since the formation of the lens unit and the individual separation process can be performed in a lump by unit of each package substrate, i.e., the subsequent processes can be performed at a wafer level, automation of the formation process can be achieved. Accordingly, a method for manufacturing a light emitting device package according to an embodiment of the disclosure can contribute to the reduction of the percentage of defects and the improvement of productivity, and can reduce the manufacturing cost.

Meanwhile, the subsequent processes such as formation of the lens units after the selective mounting of the first to fourth light emitting devices **110\_1** to **110\_4** onto the first to fourth package substrates **20** to **50** are described as being sequentially performed for each of first to fourth light emitting devices **110\_1** to **110\_4**, but this is merely for convenience of explanation, and the disclosure is not limited thereto. For example, the subsequent processes may also be simultaneously performed for each of the first to fourth package substrates **20** to **50** after the selective mounting process of the first to fourth light emitting devices **110\_1** to **110\_4** has been completed.

FIGS. **16A** through **16D** are plan views illustrating planar shapes of a growth substrate **60** based on the order of the light emitting devices being mounted in a package substrate according to certain other embodiments of the disclosure. For explanation of FIGS. **16A** to **16D**, since a method of selectively mounting light emitting devices on the growth substrate **60** in the corresponding package substrates with bonding patterns and performing individual packaging through subsequent processes is substantially similar to the method described in FIGS. **1A** to **15**, a detailed description thereof will be omitted herein, and the following description will be focused on a point that the light emitting devices are grouped and processed in package.

Referring to FIGS. **16A** to **16D**, first to fourth light emitting device groups **610\_1** to **610\_4** which are similarly modularized may be repeatedly arranged on the growth substrate to form a matrix shape. Specifically, based on the first light emitting device groups **610\_1**, the second light emitting device groups **610\_2** adjacent thereto in the row direction (X-direction), the third light emitting device groups **610\_3** adjacent thereto in the column direction (Y-direction), and the fourth light emitting device groups **610\_4** may be repeatedly arranged on the growth substrate **60** to form the matrix shape.

The first to fourth light emitting device groups **610\_1** to **610\_4** may each include four individual light emitting devices **610** that are adjacent to one other. However, the disclosure is not limited thereto, and the first to fourth light emitting device groups **610\_1** to **610\_4** may each variably include at least two light emitting devices that are adjacent to each other according to the output characteristics of the light emitting device packages that are required.

The first to fourth light emitting device groups **610\_1** to **610\_4** may be sequentially mounted in their corresponding package substrates. Thus, since the first to fourth light emitting device groups **610\_1** to **610\_4** can be mounted in their



corresponding package substrates while being spaced apart from one other by at least one light emitting device in the row direction (X-direction), the column direction (Y-direction), and the diagonal direction (D-direction), a gap between units modularized for the subsequent processes can be sufficiently secured.

Thus, the formation of the lens units and the individual separation processes can be more easily and accurately performed even when a high output light emitting device package including a plurality of individual light emitting devices is manufactured. Also, since the formation of the lens units and the individual separation processes can be performed at a wafer level, the automation of the formation process and the improvement of productivity can be achieved.

As shown in FIGS. 16A to 16D, the mounting order is not limited to the mounting order of the first to fourth light emitting device groups 610\_1 to 610\_4, and the first to fourth light emitting device group 610\_1 to 610\_4 may be mounted in their corresponding package substrates in different orders.

FIGS. 17A through 17C are plan views illustrating planar shapes of a growth substrate 70 based on the order of the light emitting devices being mounted in a package substrate according to certain other embodiments of the disclosure. For explanation of FIGS. 17A to 17c, since a method of selectively mounting light emitting devices on the growth substrate 70 in the corresponding package substrates with bonding patterns and performing individual packaging through subsequent processes is substantially similar to the method described in FIGS. 1A to 15, a detailed description thereof will be omitted herein, and the following description will be focused on a difference between the horizontal sections of the light emitting devices.

Referring to FIGS. 17A to 17C, a plurality of light emitting devices 710 disposed on the growth substrate 70 may have a polygonal shape, e.g., hexagonal shape in horizontal cross-section, but the disclosure is not limited thereto. For example, the plurality of light emitting devices 710 may have various kinds of horizontal cross-section such as a triangle or a pentagon.

The plurality of light emitting devices 710 may be repeatedly arranged over the top surface of the growth substrate 70 in the column direction (Y-direction) and the first or second diagonal directions D1 or D2 to form a honeycomb shape. In the plurality of light emitting devices 710, the first light emitting devices 710\_1, the second light emitting devices 710\_2 adjacent thereto in a first diagonal direction (D1-direction) or second diagonal direction (D2-direction), and the third light emitting devices 710\_3 adjacent thereto in the column direction (Y-direction) may be repeatedly arranged to form the honeycomb shape.

The first to third light emitting devices 710\_1 to 710\_3 may be sequentially mounted in their corresponding package substrates, respectively. Thus, the first to third light emitting devices 710\_1 to 710\_3 may be mounted in their corresponding package substrates while being spaced apart from one other by at least one light emitting device in the first and second diagonal directions (D1 and D2-directions) and the column direction (Y-direction), securing a sufficient gap between units modularized for the subsequent processes.

Thus, the formation of the lens units and the individual separation processes can be more easily and accurately performed upon manufacture of the light emitting device package, and can be performed at a wafer level, thereby enabling the automation of the formation process and the improvement of productivity. Also, the manufacturing process can be sim-

plified due to the selective separation of the light emitting devices and the reduction of the number of times mounting steps are performed.

As shown in FIGS. 17A to 17C, the mounting order is not limited to the mounting order of the first to third light emitting devices 710\_1 to 710\_3, and the first to third light emitting devices 710\_1 to 710\_3 may be mounted in their corresponding package substrates in different orders. Also, as shown in FIGS. 16A to 16D, the plurality of light emitting devices 710 may also be mounted on and packaged in the package substrates by light emitting device groups each including at least two light emitting devices that are adjacent to each other.

While the disclosure has been particularly shown and described with reference to exemplary embodiments thereof, it will be understood that various changes in form and details may be made therein without departing from the spirit and scope of the following claims.

What is claimed is:

1. A method of manufacturing a light emitting device package, comprising:

preparing a growth substrate comprising a plurality of light emitting devices disposed on a top surface of the growth substrate;

preparing a first package substrate having a plurality of bonding patterns corresponding to some light emitting devices from among the plurality of light emitting devices, the bonding patterns being disposed on a top surface of the first package substrate, and each bonding pattern includes a first conductive region and a second conductive region spaced apart from the first conductive region;

bonding said some light emitting devices from among the plurality of light emitting devices and the bonding patterns by disposing the top surface of the growth substrate to face the top surface of the first package substrate so that each light emitting device overlaps and is in direct contact with the first conductive region and second conductive region of the corresponding bonding pattern;

separating said some light emitting devices from among the plurality of light emitting devices from the growth substrate; and

packaging said some light emitting devices from among the plurality of light emitting devices joined to the bonding patterns.

2. The method of claim 1, wherein said some light emitting devices from among the plurality of light emitting devices are spaced apart from one another by at least one light emitting device.

3. The method of claim 1, wherein said some light emitting devices from among the plurality of light emitting devices is divided into groups comprising at least two light emitting devices that are adjacent to each other, and the groups are spaced apart from one another by at least one group.

4. The method of claim 1, wherein the separating said some light emitting devices from among the plurality of light emitting devices comprises selectively performing a laser lift-off on said some light emitting devices from among the plurality of light emitting devices.

5. The method of claim 1, wherein the packaging of said some light emitting devices from among the plurality of light emitting devices further comprises:

forming, over the first package substrate, lenses surrounding said some light emitting devices from among the plurality of light emitting devices, respectively; and cutting the first package substrate to form units from said some light emitting devices from among the plurality of

light emitting devices, wherein each of the units comprises one of the plurality of light emitting devices and one of the lenses.

**6.** The method of claim **1**, further comprising:

preparing a second package substrate having a plurality of 5  
bonding patterns corresponding to other light emitting devices from among the plurality of light emitting devices remaining in the growth substrate, disposed on a top surface of the growth substrate;

bonding said other light emitting devices from among the 10  
plurality of light emitting devices remaining in the growth substrate and the bonding patterns of the second package substrate by disposing the top surface of the growth substrate and a top surface of the second package substrate to face each other; and 15

separating said other light emitting devices from among the plurality of light emitting devices bonded to the bonding patterns of the second package substrate from the growth substrate.

**7.** The method of claim **6**, wherein the first package substrate and the second package substrate are separate from each other. 20

**8.** The method of claim **1**, wherein second conductive region is wider than the first conductive region.

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